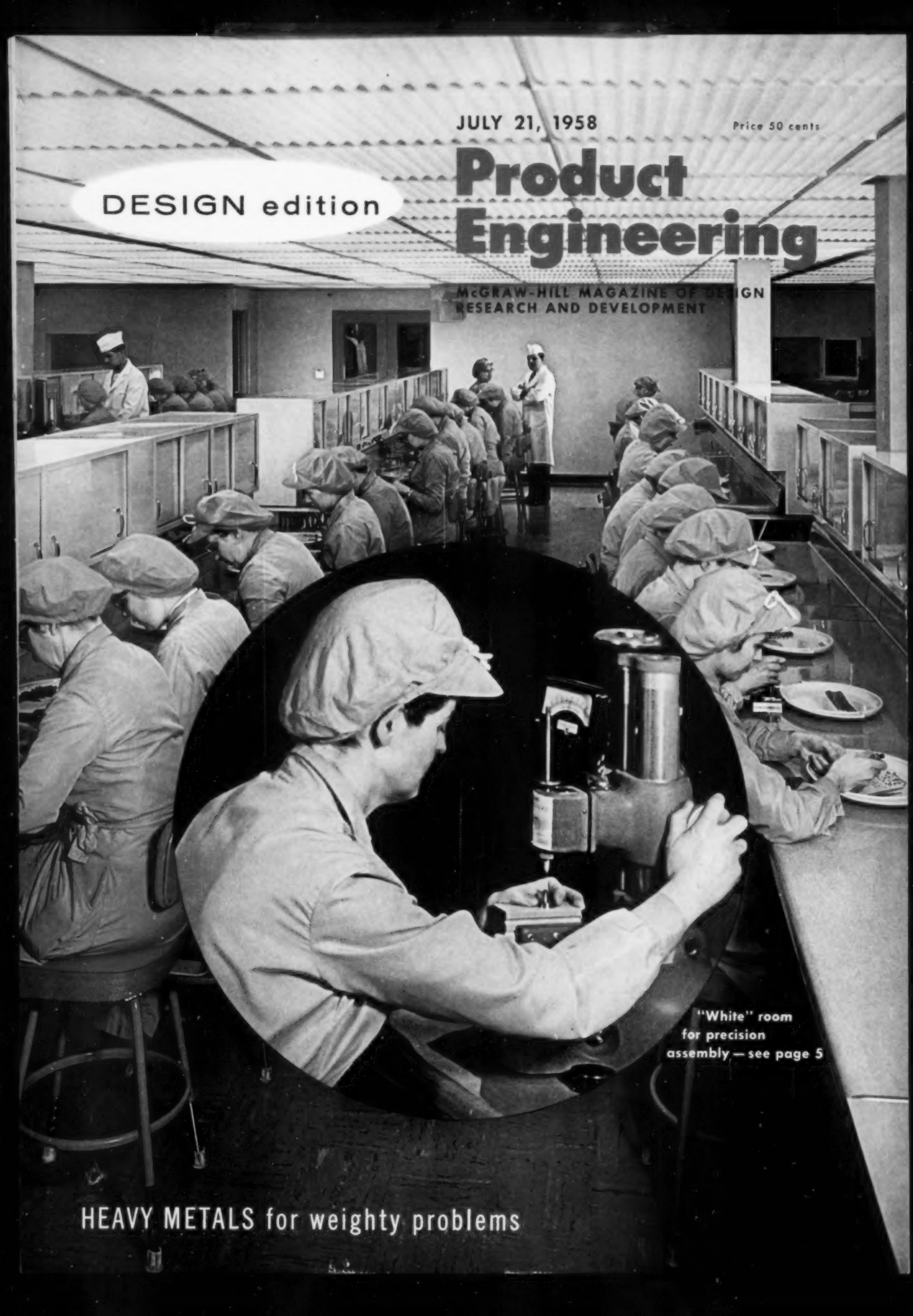
JULY 21, 1958

Price 50 cents

DESIGN edition

Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN
RESEARCH AND DEVELOPMENT



"White" room for precision assembly — see page 5

HEAVY METALS for weighty problems

C/R now offers you the advantages of reinforced TFE... designed, compounded and molded by a single source!

If your work involves sealing applications, you are probably familiar with "Teflon", Tetrafluoroethylene Resin. The extreme versatility of its chemical, thermal and mechanical properties are unmatched by any other material on the market.

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It is also useful to know that Chicago Rawhide is one of the few fabricators which blends its own "Teflon" compounds, assuring constant quality in batch after batch and permitting compound formulations to be developed rapidly and accurately. Our new laboratory and production facilities are unexcelled – and these facilities are matched by our experience in molding synthetic parts to meet the most critical specifications.

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If you are interested in "Teflon" write for your free copy of Sirvene Materials Bulletin C.T-1.

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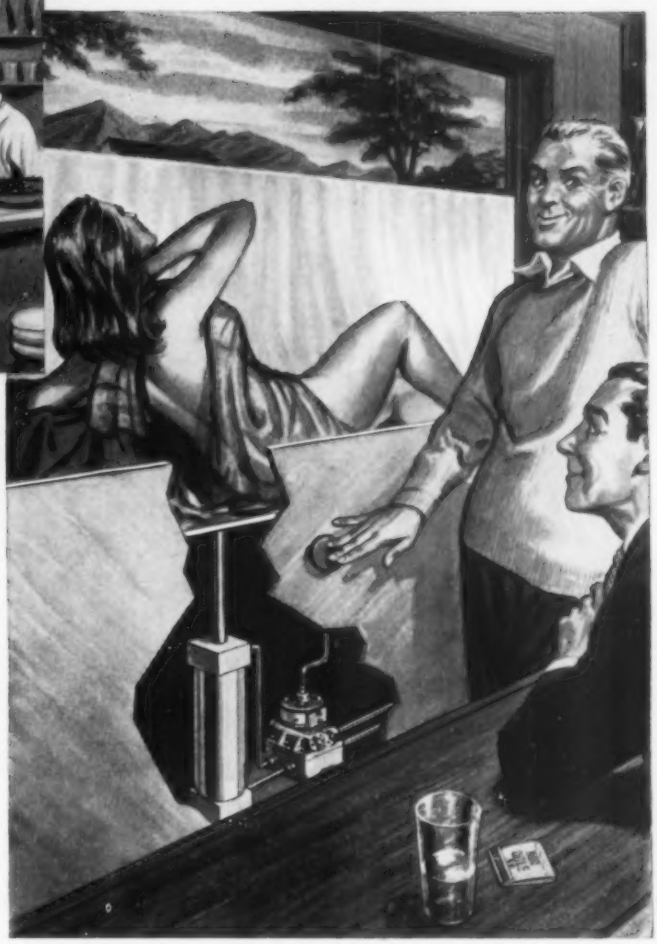
Other C/R Products: *C/R Shaft and End Face Seals • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears*

SIRVENE C/R DIVISION
CHICAGO RAWHIDE



What! Painting or Etching to Suit the Occasion!

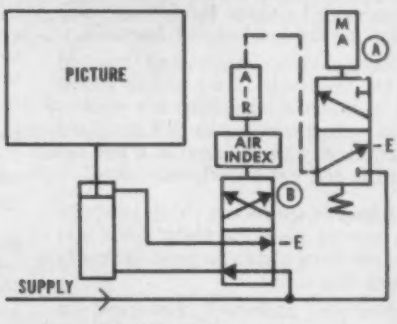
This "one knob picture control" is unlikely we will agree, but . . .

Art tastes do vary. The boys may not wish to share theirs with the spouses . . . in fact they may not *dare* to. And it might even call for a quick disappearing act for the little lady who is wearing little more than a blush. Unlikely as this device is, it would efficiently accomplish this neat scene change for such "art lovers." In the meantime, it gives us a chance to show something new. How one valve can now extend a double acting cylinder, letting it remain extended when the valve is released, then retract the cylinder at the next actuation by using the new Ross momentary air index adaptor.

The Ross air indexing momentary has hundreds of serious uses

Now, a standard Ross Skyline valve, either solenoid or air operated can include this momentary air index adaptor. Then the first actuation will send the valve one way and it will stay in that position, even when the actuator releases. The next stroke reverses the valve, again it stays after actuator release, etc.

See your Ross representative for application information.



SEQUENCE OF OPERATION

1. Valve (A) is manually actuated, valve (B) reverses and stays put, keeping pressure on one side of double-acting cylinder.
2. When Valve (A) is manually actuated again, valve (B) reverses and stays put, keeping pressure on opposite side of double-acting cylinder.

Ross OPERATING VALVE CO.

114 East Golden Gate • Detroit 3, Michigan

Unscheduled fire drill at Carle Place (N. Y.) High School. Building was vacated in two minutes, ten seconds . . . fast, but not as fast as an automatic fire sprinkler system goes to work.

How fire puts itself out

Only two minutes and ten seconds have gone by since the school's bell rang for an unscheduled fire drill.

Everybody's out now. And so would be the fire itself—*in a building where an automatic sprinkler fire protection system stands guard.* This is one certain way to extinguish a fire before it can get anywhere.

Automatic sprinklers today are built to remain pressure tight for years . . . yet designed to respond *instantly* when fire starts.

Certain foolproof materials in their construction hold the key to this performance. Inconel* nickel-chromium alloy valve springs, for example, which one famous maker uses in the sprinkler head.

Regardless of how long they wait in tensed readiness, Inconel alloy springs stay in shape . . . keep their resiliency for trigger-quick response when fire breaks out. And because Inconel alloy resists corrosion under even the severest conditions, the springs provide a lasting, water-tight seal all the time they wait.

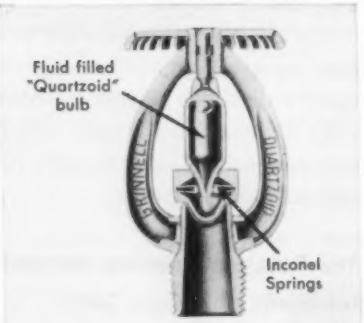
By the way, if you would like to have the important facts and information about this nickel-chromium alloy, just ask us for "Engineering Properties of Inconel."

Do you have a metal problem in which corrosion is a major factor? Or wear? Or high temperatures? Or some destructive *combination* of conditions? Then look into the Inco Nickel Alloys. Their properties are described in a helpful booklet called *Standard Alloys for Special Problems.* Write for a copy.

*Registered trademark

The International Nickel Co., Inc.

67 Wall Street INCO New York 5, N. Y.



In fire-fighting trim. Cutaway view of automatic sprinkler manufactured by the Grinnell Corporation, Providence, R. I. Fluid-filled "Quartzoid" bulb bursts when temperature reaches danger point. This action releases the tensed Inconel alloy springs that hold the valve closed with 155 pounds load, starts sprinkler system immediately.

INCO NICKEL ALLOYS

NICKEL ALLOYS PERFORM BETTER LONGER

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

JULY 21, 1958 Vol. 29, No. 29

STAFF REPORT

Heavy Metal Solves Weighty Problems* 62... Annesta R. Gardner, Associate Editor
A group of tungsten alloys with a deceptively simple name is tackling complex new jobs. Here's how you can put these high-density materials to work.

Measuring Temperature Inside Solids 65... W. H. Giedt and D. L. Rall, Detroit Controls Corp.
Thermistors . . . thermocouples . . . resistance elements? The authors compare these devices that tell the exact temperature at critical points in the material.

SPECIAL REPORT

Hardenable Titanium 68... Robert W. Carson, Managing Editor
A fast run-down on Crucible Steel's new age-hardening B-120VCA. It has highest strength-weight ratio of any alloy in its 600-to-800-F service range.

Design Features in New Products 70... Packaged air starts turbines; real rotors and controls for simulated helicopter; tapped nuts here guide the tapper; versatile lathe cuts tool cost.

Goodbye Ammonia Fumes in Print Room 74... Haakon Johnson, University of California
The nuisance was overcome with added vents and a switch-over from gas in solution to gas piped from bottles.

New Superalloy Bids for Hot Jobs 76... F. K. Iverson and M. A. Pohlman, Cannon-Muskegon Corp.
It's between 1200 and 1800 F that Rene 41, in sheet form, claims superiority. Article gives comparison curves.

Drum Camera Puts Motion on Record* 78... Dr. Karl Maier, Olin Mathieson Chemical Corp.
Fast-moving parts show a "cardiogram" of their acceleration and velocity that can be read quickly off curves. Author compares this speedy method with its three rivals.

DESIGN FILE

15 Plate-stiffeners Compared 82... A foreign digest
Tests at Munich University show the strength differences.

Bending and Torsion Strength of Thin-walled Cylinders 85... Irene Kusmiss, Walter Kidde Co.
Article gives curves and safety margin formulas.

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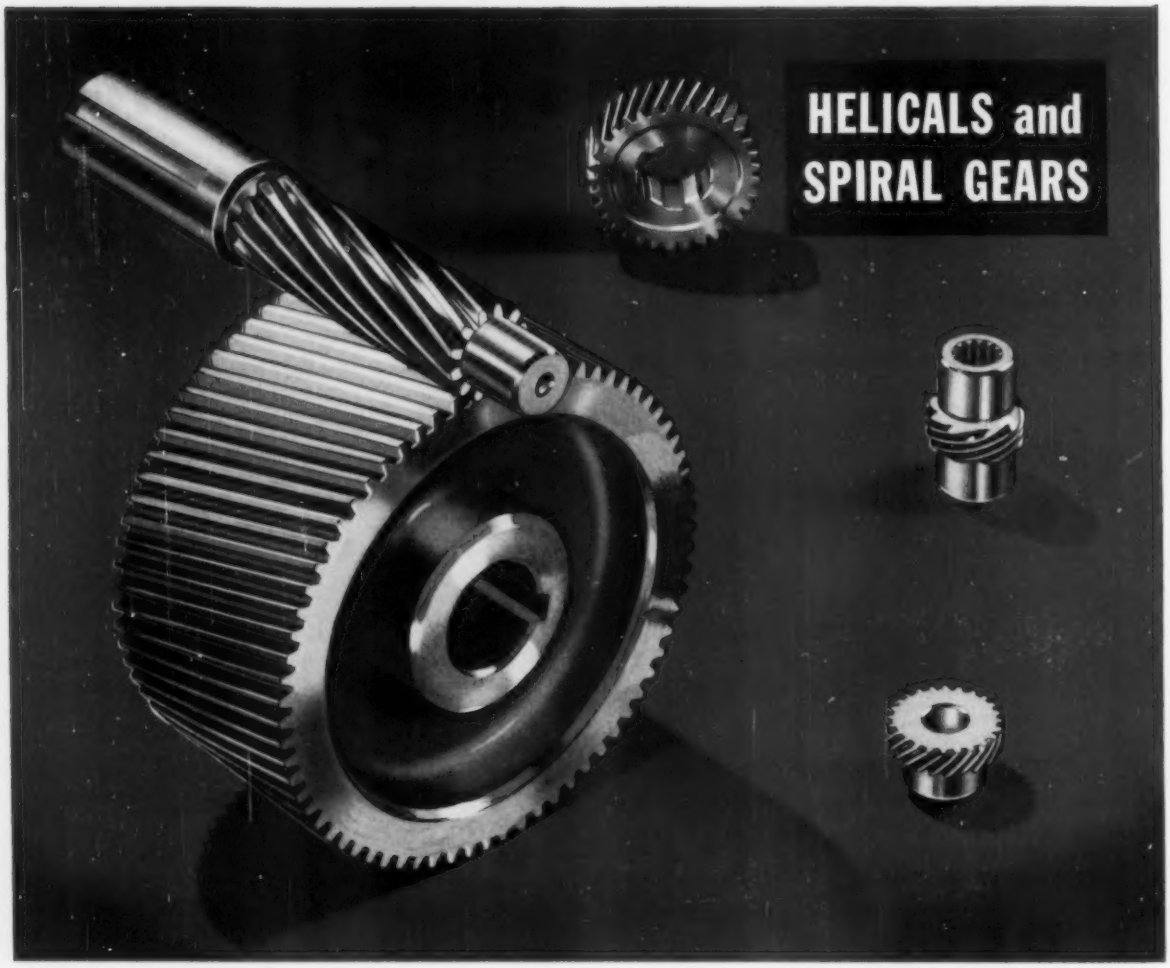

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Interesting to Note . . .

The White Room

That modern bathroom you've always dreamed of installing is actually as old as the Greeks. True, modern improvements have contributed greatly to the mechanics of personal health, yet the actual style and design found in today's homes was copied from civilizations dating centuries before Christ. There was a period during the 17th and 18th centuries when cleanliness was totally neglected. Then came a back-to-nature movement emphasizing cold-water baths as a general cure-all. Now at long last, according to one toilet soap manufacturer, for the first time in our lives we can really feel clean.

Industry also faces a concern for cleanliness. Miniature Precision Bearings, Inc., Keene, N. H., for example, produces tiny ball bearings that are incorporated in precision machines. Since a speck of dust as small as one millionth of an inch can balk proper operation of the bearings, the company has designed and built a special room for the final assembling, cleaning, inspection and packaging. Within this "White Room," pictured on our cover, is extensive air-conditioning, filtration and precipitation equipment, plus the isolation of dust-producing machinery. A pressurized air lock keeps out air from the rest of the plant. To reach the room one must pass through an air lock, don nylon smock and cap, walk on a gelatinous mat, then pass a brushing machine that removes shoe dirt. The room is kept so clean that it contains no dust particles larger than one millionth of an inch.

The Ammonia Whiffers

Changing a base metal to gold was the goal of any good alchemist. In working toward this goal he often contributed knowledge that helped build the science of today. The alchemist not only worked with metals like zinc, mercury, iron and copper but literally any substance he could get his hands on. In early Egypt, around the 4th century B.C., alchemists found that by heating the excrement from camels, a pungent, stifling aroma resulted that was considered beneficial for certain ailments. Since this "remedy" was first produced beside the temple of Jupiter Ammon, Egyptian alchemy called its drug—*salt of Ammon* (hence *sal ammoniac*). The smell, of course, was from what we call ammonia.

About the same time, strange as it may seem, Arabs were discovering that by heating the hoofs and antlers of animals, particu-

(Continued on page 7)

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BY A MERE COIL CHANGE

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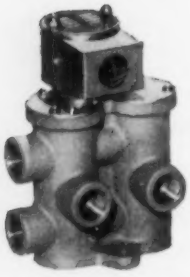
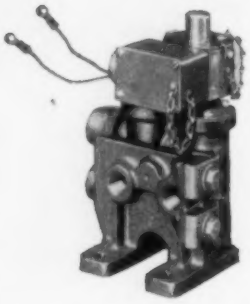
ANY VOLTAGE



Standard 4-Way



J.I.C. Type 4-Way

Standard 3-Way

® 4-Way and 3-Way Solenoid operated, pilot controlled valves for Air, Water and light oil to 150 P.S.I., products of Crescent Valve Co.

NO COIL BURNOUT

because a generous power margin, short solenoid travel and pilot operation combine to prevent overheating and overloading. Note that these valves are accepted and used in automotive plants where assembly line production does not permit coil or valve failure.

LONG SERVICE LIFE

Main valve design is aimed at extremely long trouble free service. Resilient seats are tight sealing and are not affected or damaged by dirt or grit because they are of a self scavenging design. Witness their superior performance in such severe service as operating hopper doors on cement batching equipment and in other dusty environment.

INTERCHANGEABILITY

Solenoids and pilot sections are interchangeable from one valve size to another, minimizing spare parts requirements. Adaptation to any practical voltage is achieved by a simple coil change.

Speed of response, speed of installation and dependable leakproof operation year in and year out are responsible for the increasing switch to Crescent valves on production machinery where time is money.

CONTROL VALVE DIVISION

barksdale valves

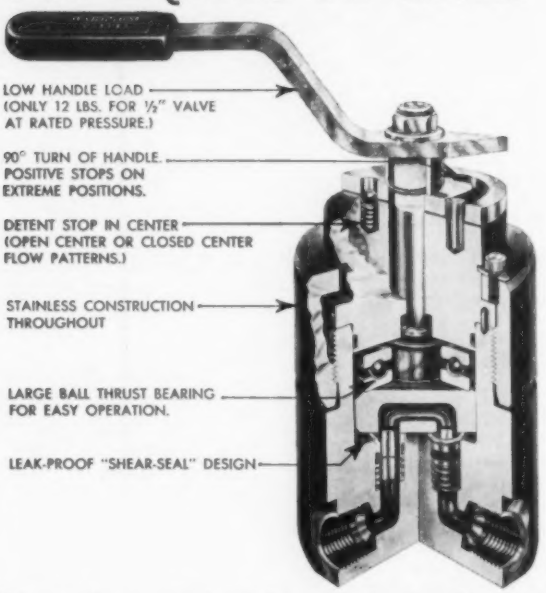
Write for Catalog 6-C

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

10,000 P.S.I.

4 WAY VALVE

FOR LIQUIDS OR GASES


LOW HANDLE LOAD (ONLY 12 LBS. FOR ½" VALVE AT RATED PRESSURE.)
90° TURN OF HANDLE. POSITIVE STOPS ON EXTREME POSITIONS.
DETENT STOP IN CENTER (OPEN CENTER OR CLOSED CENTER FLOW PATTERNS.)
STAINLESS CONSTRUCTION THROUGHOUT
LARGE BALL THRUST BEARING FOR EASY OPERATION.
LEAK-PROOF "SHEAR-SEAL" DESIGN

This new four-way valve series comes in pipe sizes from ¼ to 1 inch, but may be obtained with tube, AND 10050, or any preferred special high pressure connection. It will withstand surges of up to 15,000 P.S.I. without damage to the valve's sealing qualities. It is designed for a burst pressure of 30,000 P.S.I.

No port to port leakage occurs in the detented positions because of the exclusive "Shear-Seal" design.

Long, maintenance-free service is assured because the optically flat metal to metal sealing surfaces of the sealing rings and mating rotor faces are protected by staying in constant intimate contact; flow is always through the center of the "Shear-Seal", never across sealing surfaces (as in conventional valve design). Sealing qualities actually improve as the self aligning "Shear-Seals" lap themselves to a more perfect fit with each valve operation.

Of course, there is no external shaft leakage, because the pressure is confined to the flow passages.

CONTROL VALVE DIVISION

barksdale valves

Write for Catalog 58-59

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Interesting to Note . . . . *(continued)*

larly the hart (deer), the same sharp, vile odor resulted. So the Arabs named their remedy *spirits of hartshorn*. Alchemists used ammonia, in solution and in salt form, for years before Joseph Priestley in 1781 actually isolated the gas by trapping it over a mercury bath.

The Arab who was ammoniated as a health cure got better as a result, or in spite of, the aroma. The technician exposed to the same pungent odor from print-developing machines today may take solace in the development described on page 74.

An Ancient Dream

As early scribblings on cave walls show, man has long shown his admiration for flying creatures. Since man himself couldn't get off the ground, he gave the power to Gods like Mercury and Cupid. According to legend, the first human who actually flew was Daedalus, who fashioned wings from feathers and wax. With his son, Icarus, he took flight, literally, from the Isle of Crete and headed for Sicily. Daedalus flew low and slow and arrived on schedule, but his son went too high. The wax melted, the feathers loosened, and he fell into the body of water which long bore his name, the Icarian Sea (now part of the Aegean Sea).

In 1678 a French locksmith, Besnier, tried to fly by attaching pedals to the ends of two poles. He put a pole on each shoulder and claimed he actually flew. Unfortunately nobody saw him. The Marquis de Bacqueville in 1742 told the citizens of Paris he would fly across the Seine, using large paddle-shaped wings. A large crowd assembled and watched the Marquis flap his arms from a rooftop, then drop to the street below. He broke a leg.

It wasn't until this century that we achieved controlled flight. Now, with advent of one-man helicopters (see page 71) man at last has the power to fly in somewhat the way the ancients always pictured.

Thermometer for a Fossil

From the first blow of flint against an iron rock, the early firemaker faced the problem of using heat. It didn't take Palaeolithic man very long to realize that fire could be beneficial if controlled; deadly if not. Since fire was first used solely for warmth, protection, cooking and light, temperature control meant little. When it was discovered that iron and copper could be softened and formed by using a flame hotter than a burning log, temperature control became an art. Some woods would burn hotter than others; wind caused flames to turn bluish and for some reason softened a metal quicker; flame color became a factor in measuring temperature. Today, of course, such methods as discussed on page 65 can be considered for precision temperature-measurements.

An interesting development in thermometry occurred in 1946 when the Nobel prize winner, Dr. Harold C. Urey, discovered that the ratio between oxygen isotopes in a fossil shell could determine the temperature of the water in which the original creature existed. This "thermometer" will be a valuable instrument in studying climatic changes and glaciation.

Lost Art

Back in the 1920s our public fancy was stirred by some discussion—mostly in Sunday supplements—about the "lost art" of hardening copper, often attributed to a secret the last of the Aztecs took with them to the grave. Sometimes it was the Egyptians who were supposed to have it—and lost it. But there was this pseudo-scientific discussion of an alchemy that would mysteriously confer on soft easily worked and ageless copper the hardness and keenness of edge obtainable with steel.

We haven't heard much about this "lost art" since some German metallurgists in the early 1930s discovered the precipitation-hardening characteristics imparted to copper by the addition of 2% beryllium. For this product of scientific research (not alchemy) brought forth a material that in some ways even exceeded the spectacular properties popularly attributed to the mysteries of the lost art.

And now we have a broad range of useful materials that can be formed or worked in a soft condition (solution annealed) and then given high hardness and strength by a simple aging heat treatment. Among some of the more common are duralumin, K-monel, beryllium nickel, hardenable stainless—and now, hardenable titanium (page 62). The Aztecs never had it this good.

—Benedict A. Leerburger Jr.

Index to Volume 29 Now Ready

A 16-page printed index of editorial content in all issues for the first six months of 1958 is now ready. Copies may be obtained by circling No. E35 on one of the Reader Service Cards bound inside the back cover of this issue.

Hereafter, the Index will be issued twice each year, in July and January, and copies will be supplied on request without charge as long as the supply lasts. A limited supply of the Index for Volume 28 is also still available on request.

ELECTRONIC and ULTRASONIC quality control of MUELLER rod, tube, fabricated parts and

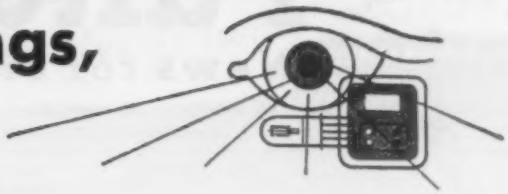
Every practical electro-mechanical testing device available to industry today is used by the Mueller Brass Co. to maintain Positive Quality Control during each manufacturing operation. From the first stages of alloying, spectroscopic analysis is used to maintain exact alloy composition so that they are precisely as specified. Ultrasonic test equipment is utilized in the non-destructive testing of extruded brass and bronze rod, copper tube, forgings and fabricated parts. In machining and finishing operations, statistical quality control is employed to eliminate the effect of possible human error. These quality controls are all designed for one purpose . . . to give you complete "product protection."

•

Copper base alloy rod is examined by a trained operator with the aid of an ultrasonic reflectoscope. Through electronic circuitry, ultrasonic echoes are translated on a cathode ray tube. Any internal flaws are readily apparent. Both rod and tube are tested by this method, which is just one of many Positive Quality Control checks used by the Mueller Brass Co.

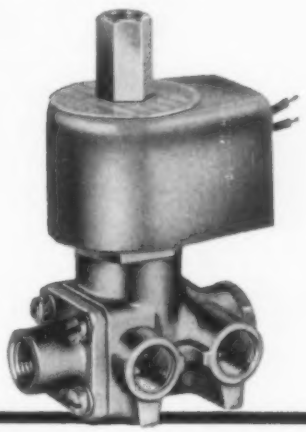
Through ultrasonics, the immerscope (Left) locates internal defects, and has exceptional versatility for examining intricately shaped parts, such as the forging being checked in this photo. When testing, a transducer, located at the bottom end of the search tube, is electronically actuated to produce from 2.2 to 25 million cycles per second. Ultrasonic echoes are reflected back to the transducer from the material, indicating any defects that may be present. Limits may be pre-established and the sound findings are visually recorded on the cathode tube. This is another instance of Positive Quality Control in action.

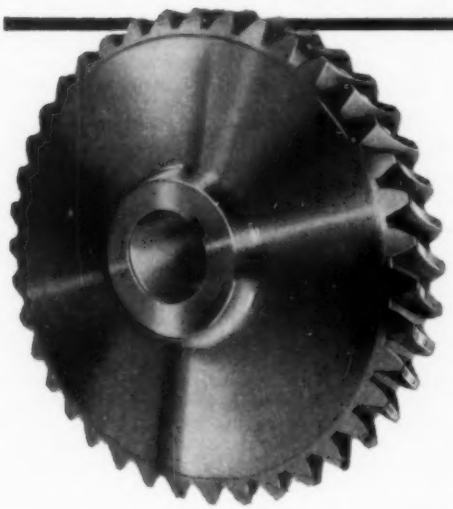
TESTING helps insure positive BRASS CO. forgings, assemblies...



The direct reading spectrometer (Left) makes it possible to accurately analyze an alloy for chemical composition within 90 seconds while the metal is in the molten stage. A sample specimen is poured, cooled and sent to the laboratory, where it is placed in the spectrometer. Through the diffraction gratings in the machine, the "spectrum" analysis of the alloy records its exact chemical composition. With this equipment, alloy specifications are matched exactly, thus insuring a better finished product through Positive Quality Control.

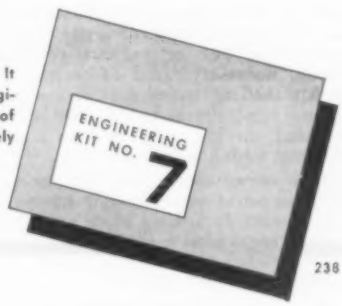
THIS MIDGET 4-WAY SOLENOID VALVE (Right) is one of a complete line designed and manufactured by the Automatic Switch Co. (ASCO) of Florham Park, New Jersey. Valves of this type are used for controlling small double acting cylinders which operate valves, dampers and many types of automatically controlled equipment. One of the most important components in these valves is the non-porous brass body forged by the Mueller Brass Co. who also perform all the major machining operations so that the body is ready for use upon delivery. The forged brass body insures freedom from porosity and reduces possibility of corrosion. The Mueller Brass Co. Positive Quality Control program insures ASCO complete "product protection". . . and eliminates chance of "in-service" failures.





THIS LARGE 18" FORGED GEAR, along with two others of the same type, is used in a steam turbine installed in a power generation facility of the Wisconsin Electric Power Company, at Port Washington, Wisconsin. The gear was forged in open dies by the Mueller Brass Co. from tough, long-wearing 603 alloy. The gear operates at 25-30 RPM and is turned by the turbine, which has a capacity of 80,000 kilowatts. Strength and dependability are of utmost importance in applications like this, and in such cases Positive Quality Control insures peak performance.

Write for your engineering kit no. 7. It contains complete laboratory and engineering data plus typical examples of Mueller Brass Co. products used in widely diversified applications.



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MUELLER BRASS CO. PORT HURON 22, MICHIGAN

The Panelbuilder

60 YEARS OF SERVICE
CUTLER-HAMMER CONTROL C-H

News for and about Panelbuilders

Cutler-Hammer Inc., Milwaukee, Wis. *Division:* Airborne Instruments Laboratory. *Foreign:* Cutler-Hammer International, C. A.
Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation, Inc.

SYNCHRONOUS TIMERS PROVIDE GREATER ACCURACY, FLEXIBILITY, DEPENDABILITY

Recently, Cutler-Hammer announced a new line of synchronous motor driven control timers. Available in one, three, and five minute models, the new timers are ideally suited for all industrial control systems requiring a precise, easily adjustable, dependable timing relay.

Timer Dial Reads Directly in Seconds

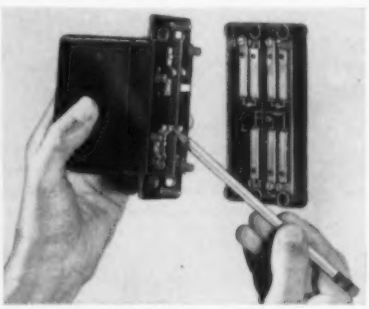
One of the many plus features of these Cutler-Hammer Synchronous Control Timers is the timer dial which is calibrated directly in seconds. No longer is it necessary to guess at setting the timing interval. Just rotate the bronze pointer to the dial position corresponding to the exact interval desired . . . no approximations or tedious readjustments necessary. And of course, the direct reading timer dial serves as a lasting reminder as to the time setting without having to check its timing interval with a stop watch.

The sweep second pointer provides a visual count down when in operation . . . a valuable feature when setting up closely sequenced machine operations.

Automatic Operation— Greater Repeat Accuracy

The operation of these new timers is completely automatic. After each timing cycle the sweep second pointer returns to the start position. Also, the pointer will return to the start position if a power interruption occurs while the timer is in operation, thus eliminating the possibility of an undertimed cycle.

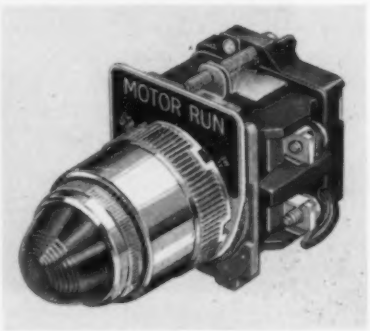
The Cutler-Hammer Synchronous Timer is ruggedly built, requiring virtually no maintenance. The timers are not adversely affected by dust or climatic changes and maintain the highest degree of repeat accuracy.



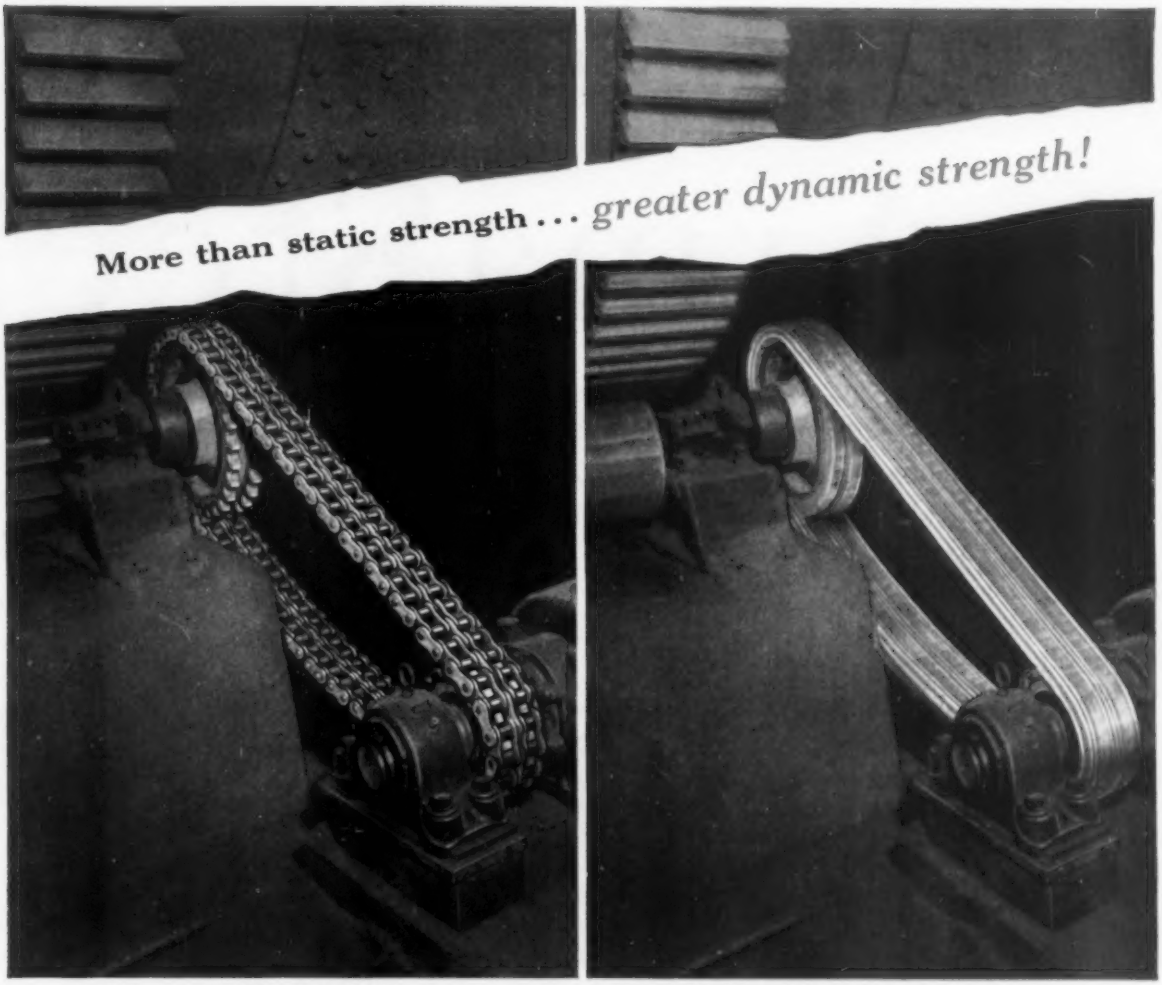
The one minute timer is adjustable in one second increments from 0 to 60 seconds, the three minute timer in 3 second increments—0 to 180 seconds, and the five minute timer in 5 second intervals—0 to 300 seconds. All three models are dimensionally identical and easily interchangeable without disturbing the mounting base or wiring. The timing unit is removed from the mounting base during installation for maximum wiring freedom.

For further information, see your nearby Authorized Cutler-Hammer Distributor or write for Publication EN-33. CUTLER-HAMMER Inc., 1332 St. Paul Avenue, Milwaukee 1, Wisconsin.

PRESTEST® INDICATING LIGHTS CHECK OWN BULB CONDITION



Indicating lights are vital to the safety and proper use of many machines, particularly in automation. But such lights always pose a troublesome question. When an indicating light is "off", is it indicating the true circuit condition or is the bulb burned out? There is no guesswork with the Cutler-Hammer PresTest Indicating Light. Merely pressing on the PresTest lens disconnects the lamp from its operating circuit and checks it instantly on a continuously energized test circuit. So simple and easy, it ends the hazards of infrequent testing. Cutler-Hammer PresTest Oil Tight Indicating Lights are amazingly compact. The resistor type requires only $1\frac{7}{8}$" back-of-the-panel space, and the transformer type requires only $1\frac{23}{32}$". The wide angle visibility lenses come in six different colors. For full information on PresTest and other matching heavy duty oil tight pushbutton units, write today on your company letterhead for the Master Design, Pub. EL-178.



More than static strength . . . *greater dynamic strength!*

RESISTANCE TO TENSILE STRESS is achieved with properly heat-treated, accurately machined side bars made of premium steel and fitted with properly hardened pins, bushings, rollers.

STRENGTH OF CHAIN IN MOTION results from such refinements as pitch-hole preparation, micro-finish of parts, special processing of side bars, pre-lubrication, rigid quality control from materials selection to final boxing.

Big reason for the extra life from LINK-BELT roller chain

STARTING shock, heavy loads and impact of sprocket engagement on modern heavy-duty machinery requires a chain that will resist fatigue. That's why Link-Belt gives you *greater dynamic strength* to shrug off stresses. Pre-stressing, closer heat-treat control, lock-type bushings, shot-peened rollers—all these Link-Belt refinements contribute extra stamina for extra life . . . provide smoother, more efficient chain performance . . . reduce drive and conveying costs.

You have a choice of single- or double-pitch, single- or multiple-width chain. Get in touch with your nearby Link-Belt office for further information.

LINK-BELT

ROLLER CHAIN & SPROCKETS

14,644-A

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

HOW CAN YOU USE THIS NEW TYPE OF

ArmaSteel®

Tensile strength, 105,000 • Minimum yield, 85,000 • Minimum elongation in 2", 2% • Brinell hardness 269-302, (3.5-3.7 mm)
Machinability 20% better than steel of same hardness!

ARMASTEEL 88M has been developed to fill the automotive industry's needs for a material having increased wear resistance and high yield strength, yet at the same time retaining good machine characteristics.

ARMASTEEL 88M does not require heat treating and thus relieves customer facilities or eliminates capital expenditures. In many parts, distortion is a problem after heat treating. Parts made from ArmaSteel 88M can be machined without further heat treatment and still give good wear resistance.

This new castable metal is a pearlitic malleable iron which possesses substantially the same strength and the same wear characteristics as alloy steel forgings. Being a castable material, it has the two advantages of design flexibility and good machinability. Why 88M possesses these characteristics—and how it will fill the needs of American industry will be of interest to manufacturers and engineers in many fields . . .

PRODUCTION OF 88M—By accurately controlling the heat-treatment of ArmaSteel 88M in controlled atmosphere furnaces at 1750° for approximately 15 hours, all massive carbides are removed. This heat treatment is followed by closely controlled oil quench and tempering operations to provide a narrow range of hardness.

Universal Joint Yoke

Automatic Transmission Planet Gear Carrier

Surface hardening of ArmaSteel, if desired, does not require carburizing. Instead, flame-hardening, induction-hardening or simple immersion methods may be used. A surface hardness of 50 Rockwell C to 60 Rockwell C can be readily obtained. Wear-resistant properties in the hardened area are comparable and sometimes better than carburized steel, while the remaining sections retain their original toughness.

MACHINABILITY—In addition to performance characteristics, ArmaSteel offers good machinability. Carbon spots that are present in the Matrix of ArmaSteel allow the chips to break off readily, effectively reducing machining time and prolonging tool life. In comparative tests, ArmaSteel shows itself to be a more freely-machining material than steel bar stock or forgings of the same Brinell hardness.

Because of its ability to assume the shape of practically any molded cavity, 88M not only permits great

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PEARLITIC MALLEABLE IRON?

88 M *developed by*

CENTRAL FOUNDRY DIVISION

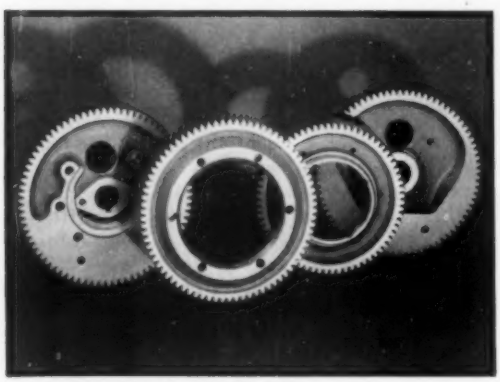
Transmission Output Shaft

freedom in design but also possesses certain inherent physical characteristics not present in forgeable alloys.

APPLICATIONS—ArmaSteel 88M is now being cast for automatic transmission planet gear carriers and universal joint yokes for leading automobile manufactures. Other interesting applications now in the testing stage include transmission output shafts, and diesel engine idler, balance and crankshaft gears.

Just what hundreds of other applications are in store for 88M is still anyone's guess. But the more one examines its characteristics, the more it would seem that it will fill many needs in many types of products and industries. In your products, for example, you may well see where 88M could both improve performance of components subject to great wear or great stress, and at the same time reduce final cost because of the economy in casting and the economy in a material with superior machining characteristics.

Diesel Engine Idler, Balance and Crankshaft Gears



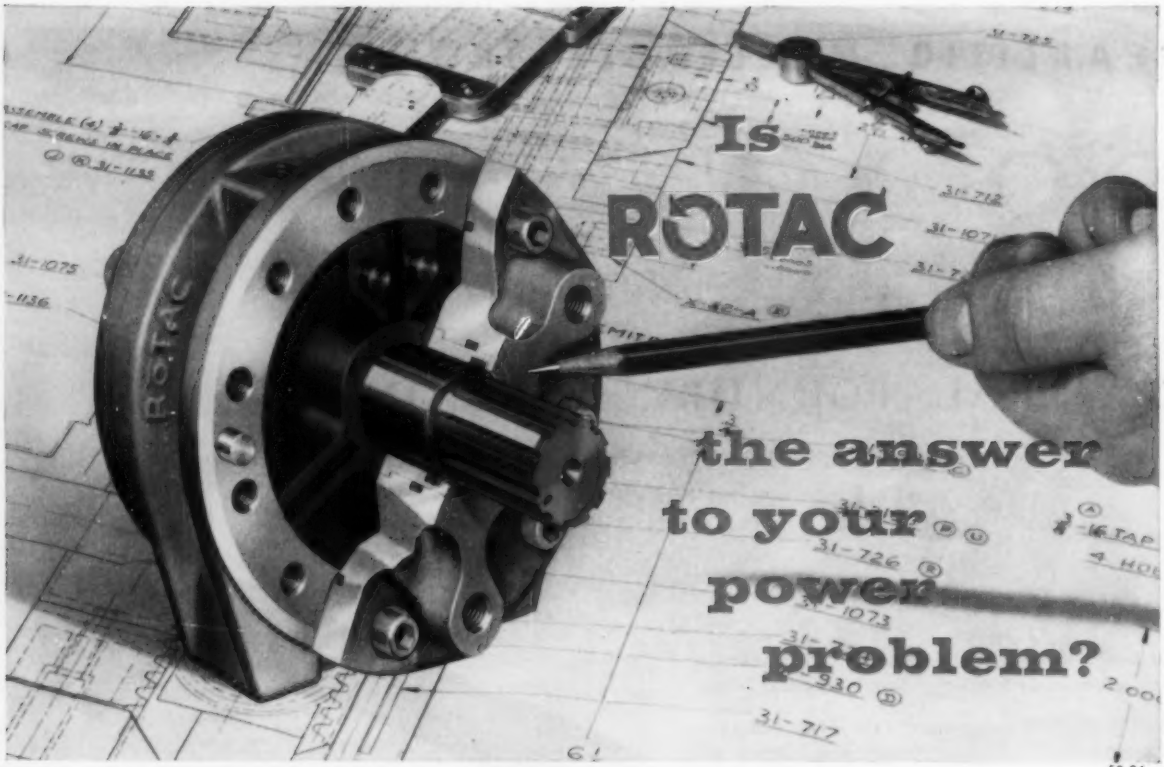
CASTING—Parts are cast in ArmaSteel 88M, here at Central Foundry Division, in either standard green-sand molds or the newer, more precise shell-molds. In addition to 88M, Central Foundry Division produces castings, on a volume basis, in grey iron, alloy grey iron, malleable iron, and ARMASTEEL 84M, 85M and 86M.

Our research facilities and engineering staff are prepared to help you determine whether 88M or any of the other materials now being cast at Central Foundry will fill your needs or help you reduce your over-all product cost.

Write for your copies of our two comprehensive manuals, "ARMASTEEL" and "SHELL CASTINGS."

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 10



Rōtac torque actuators are simple, compact—provide positively controlled power for any movement from turning watch parts to tipping railroad cars

RŌTAC Rotary Torque Actuators consist of a cylindrical chamber containing a stationary barrier or shoe, and a central shaft with a fixed vane. With fluid or pneumatic pressure applied to either side of the vane, rotary movement in the opposite direction is obtained.

There is no complex linkage, no plunger action: RŌTAC's few moving parts are completely sealed from dirt and natural elements. Patented O-rings are used around vane, shoe and end caps.

RŌTAC Torque Actuators can be mounted easily—vertically, horizontally or at any angle—with the housing held stationary, or with the body rotating around the shaft.

To simplify design problems, for versatility in extended applications, specify RŌTAC Actuators for powerful, easily controlled rotary motion in compact form.

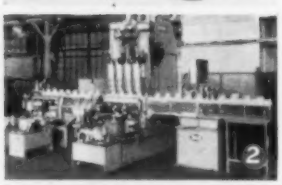
FREE DESIGN DATA BOOK—20 PAGES

Contains everything you'll want to know about RŌTAC — Installation details • Dimensions • Torque ratings • Helpful ideas for using RŌTAC Actuators in your operations.

EX-CELL-O CORPORATION

GREENVILLE PLANT, GREENVILLE, OHIO

EX-CELL-O PRECISION PRODUCTS INCLUDE: MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • TORQUE ACTUATORS • DAIRY EQUIPMENT



Just 4 of the hundreds of recent applications

1. MOBILE EQUIPMENT—A compact RŌTAC Actuator swings truck crane boom in 280° travel arc; it's controlled by a 4-way valve.

2. MACHINE TOOLS—Automation machine for boring, grooving piston wrist pin holes uses RŌTAC Actuator to orient arbors for hole alignment.

3. FOUNDRY MACHINERY—RŌTAC Actuators supply motive power for turnover of the core-box on semi-automatic shell core blower.

4. PAPER MACHINERY—Collector roll is actuated by a Model HN-63-1V RŌTAC Actuator which unloads material after slitting operation.

XLO EX-CELL-O FOR PRECISION

Time Out?

. . . or Out in Time!

Why tolerate "time outs" and aggravations of older reproduction equipment? Modern Copyflex gives you "out in time" efficiency, pays for itself in short order!

Compare the performance of your equipment with these modern reproduction advantages. See if you can really afford *not* to get Copyflex?

More Operator Conveniences. Modern Copyflex gives printing widths up to 54" to simplify feeding of large tracings, facilitate multiple feedings. Extra-large delivery trays, automatic separation, automatic stacking, and front-or-rear delivery further speed operator's work.

Faster Mechanical Speeds. New models offer sharply increased speeds—up to 30% faster than before. Synchronized exposure and development assure top quality prints, one knob control simplifies operation.

Sharp, Uniform Prints. Developing solution is applied *directly* to exposed print assuring complete, positive development at all speeds and on all types of materials.

Problem-Free Installation and Operation. Clean, quiet, odorless . . . Copyflex requires no vents or plumbing, needs only an electrical connection for operation.

If you're not getting these important advantages of Copyflex, then every day you delay is costing you time and money. You owe it to yourself and your company to investigate modern Copyflex by mailing the coupon below.

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Charles Bruning Company, Inc., Dept. 73-O
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Please send me the booklet on your new model 575 and information on the Copyflex process and machines.

Name_____ **Title**_____

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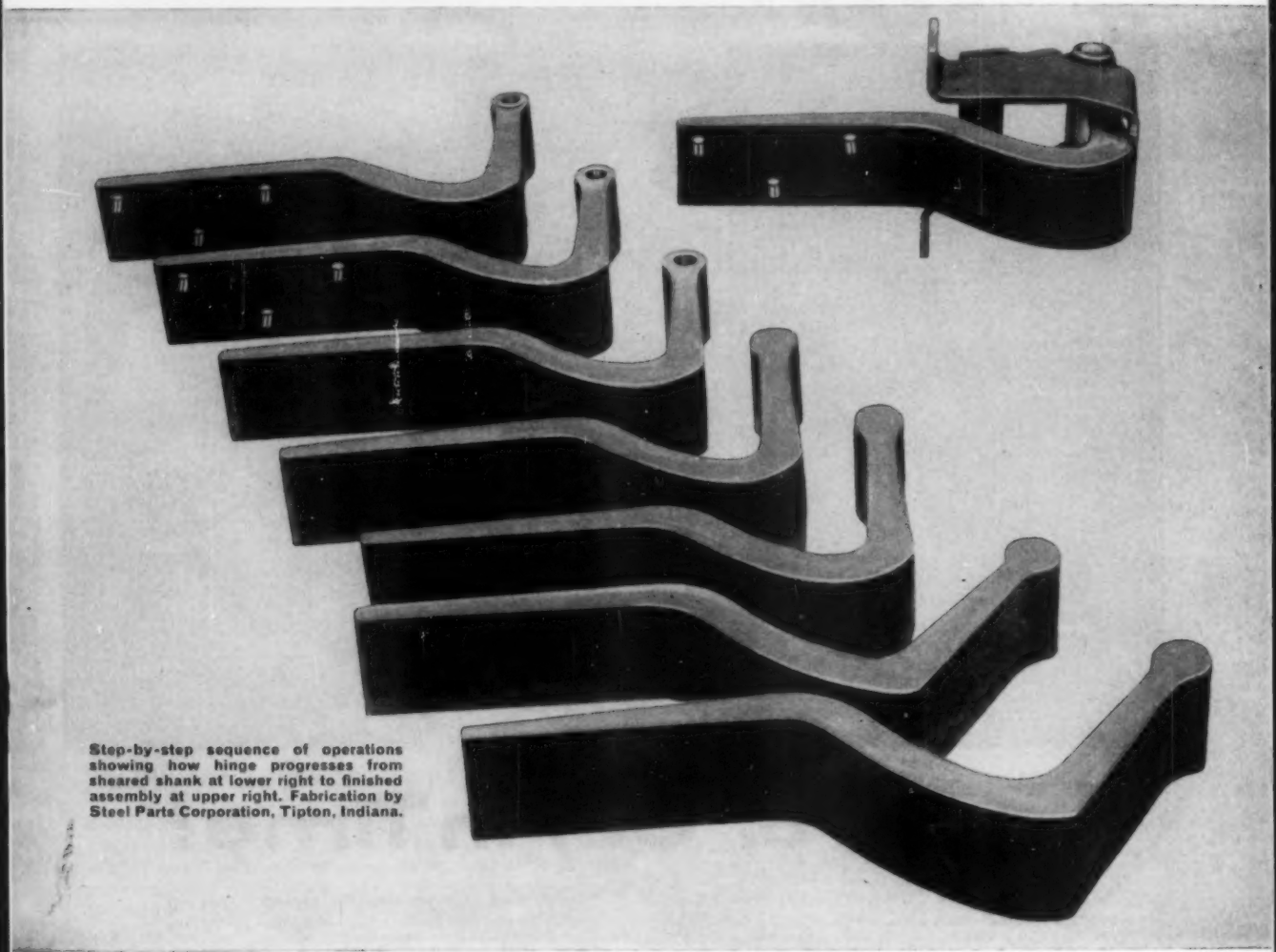
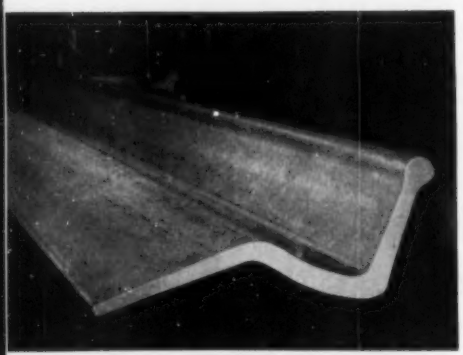
STEEL SHAPED TO CUT COSTS AND IMPROVE PRODUCTS



Step-by-step sequence of operations showing how hinge progresses from sheared shank at lower right to finished assembly at upper right. Fabrication by Steel Parts Corporation, Tipton, Indiana.

Auto door hinges made quickly . . . from steel already rolled to shape!



USS Special Section rolled to approximate dimensions of door hinge.

Hinges by the hundreds can be quickly sliced from these USS Special Section Rolled Steel Bars. Then, with a few bending, milling and drilling operations, the hinge is ready for final assembly.

This is a fast, low-cost method for producing an irregular part. There's very little machining, and scrap losses are practically eliminated. By no other method can parts like these be produced so speedily, so economically, and so strong.

Why not find out what USS Special Sections can do for you? If you are producing large quantities of parts that require extensive machining—or must be forged or cast—this method may save you money. For more information, write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

United States Steel Corporation – Pittsburgh
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Export Company

USS TRADEMARK United States Steel

DEVELOPMENTS TO WATCH...

Foamed aluminum . . .

. . . is coming to market. It will soon be available commercially from at least two sources in 3-in.-thick panels measuring up to 3 by 2 ft. Bjorksten Research Laboratory, which developed this rigid, closed-cell sponge metal (*PE—Nov.* 18, '57, p. 17), has licensed its process to Dynamic Metals of Houston, Tex., and Alumafoam, Peru, Ill.

Foamed aluminum is made by injecting gas-forming compounds into the molten metal; then quenching before the foam subsides. It can be used with, or in place of, honeycomb or expanded materials; may also be made into lightweight cast parts. Density can be varied from close to that of the solid metal to about ⅓ its weight.

Other metals, too, can be foamed—magnesium and steel, for instance. Bjorksten says these are not yet ready for commercial application, but rapid progress is being made.

"One-shot, disposable" electronic equipment . . .

. . . being developed for the Age of Rockets and Missiles poses a host of new and fascinating problems—and promises solutions that will be useful in many fields.

As Lt. Gen. Arthur D. Trudeau, Army R & D chief points out, ammunition and missile electronics requirements are almost exactly the opposite of those for communications: "In communications, we expect the item to work 999 times out of every 1000 we turn it on, and it must keep on working. In ammunition, we strive for an item that must work right the first and only time it is used—for it then serves to destroy itself."

In other words, ammunition electronic equipment is designed for indefinite storage without operation, and then must give instant and perfect service.

Ruggedness also takes on a "completely new meaning" in ammunition electronics. Components must withstand a very high order of shock, acceleration, vibration; and internal temperature.

Meeting these requirements is not easy; but it can be done, as the proximity fuse proved.

Progress in heat-to-electricity conversion . . .

. . . is portrayed here. Late last year (*PE—Dec.* 16, '57, p. 5) General Electric's Research Laboratory unveiled its first working model of such a device—a big, gas-filled tube. Last month, it showed its newest model, a tiny metal-and-ceramic button that needs no gas envelope, can operate on the flame of a blowtorch. Basic construction is the same: There are two electrodes, both held at elevated temperatures, but one hotter than the other. Electrons "boiled" out of the hotter one are collected by the cooler one; and are then conducted through an external circuit where they can be put to work.

Where may these converters be used? Now that they're down in size, applications in aircraft and missiles suggest themselves; and, eventually, GE researchers believe they can build units capable of operating in the 1 to 10-watt range, with efficiencies as high as 30%.

THERMIONIC CONVERTER, now no bigger than a quarter, is compared with original device (right). In new unit, electrodes operate in vacuum, no longer need big gas-filled tube to provide covering envelope.

DEVELOPMENTS TO WATCH...

A new hydro-pneumatic suspension . . .

. . . and a "new concept in fuel injection" are under development at Thompson Products, Inc., Cleveland; and work on a central hydraulic system for automotive and tractor use "is in an advanced stage." None of the three is ready for release yet; but Thompson expects that developments, in one of them at least, will be ready for announcement "before too long."

Major breakthrough in electronic amplification . . .

. . . is claimed by French National Center of Telecommunications Research. According to *France Actuelle*, Stanislas Teszner of CNET has developed a semiconductor device "superior in efficiency and range of use to the transistor," and capable of handling frequencies of 500 to 1000 megacycles at power outputs of several watts.

Like the transistor (see story below), the "tecnetron" uses a germanium rod (n-type), to which electrodes are attached at each end. But the new device has a third electrode—an indium ring which fits in a groove at the center of the germanium rod. When the unit is brought to the desired potential, Teszner says, "this indium ring blocks passage of the current between the two end electrodes, forming an amplifier which, once in place, will always work perfectly." He also claims that the new device is even more efficient at 500 mc than at 200, and foresees many new applications in TV, radar, and other electronic units.

Plastics for the 3500 F range . . .

. . . will be among the new materials displayed by Continental Diamond Fibre Corp. (subsidiary of the Budd Co.) at next month's Wescon show. These are not for long-term operation, of course. But CDF says molded as well as laminated parts can now be made that will take such temperatures for limited periods; and "they retain an exceptionally high percentage of their mechanical properties after exposures to these elevated temperatures for short periods."

Also being shown by the company: flame-retardant laminates for continuous use at temperatures to 300 F.

(Note: For additional information on plastics at high temperatures, and flame-retardant laminates, see *PE—June 2, p. 5 and May 26, p. 19.*)

Better gasolines and new preservatives . . .

. . . are coming from research with the alkyl boric acids, another family of the booming metallo-organic class that also includes new high-energy fuels and flame-retardant compounds.

As preservatives or "built-in germ killers," to provide lasting bacteriostatic and fungistatic protection for wood, leather, cloth, cellulose and other materials, these new compounds look extremely promising. Midwest Research Institute has been working on them, and Callery Chemical Co., Pittsburgh 37, Penna., is getting ready to produce them in quantity. And, says Callery's market development manager, C. J. Wiley, "they should also be effective preservatives for latex and polyvinyl acetate paints, cutting oils, and paper pulps."

Still under test, but showing "exciting possibilities for long-term sterilization," is the application of these compounds to glass and other hard-surface materials. MRI reports, "One of these compounds has very potent germ-inhibiting properties and adheres tenaciously to glass." (The compounds are said to have excellent wetting power.) "Once this chemical has been placed in a laboratory vessel, it must be washed repeatedly before microorganisms will grow in it again."

As to gasolines, Callery says the presence of very small amounts of the alkyl boric acids in gasoline "minimizes the increase in octane requirement of automotive engines," and can provide a base for new antiknock fluids.

At present, 10-gm samples of alkyl boric acids are being made available without charge, and larger quantities (to about 100 gm) may be purchased. Full-scale production facilities are being built, and should be in operation next year.

(Note: For information on other permanent germ-killers, see *PE—May 5, p. 5 and May 19, p. 5.* For news of other metallo-organic research, see *PE—Apr. 7, p. 5 and May 19, p. 20.*)

—ARG

Swiss Figure Out Car Parking

BASLE, SWITZERLAND—An 8-story garage—known here as an autosilo—provides this city with protected, air-conditioned parking niches for 374 vehicles. The structure, 186 ft long and 71 ft wide, is an engineering solution to the city's problem of procuring parking space in areas where land values are high. The garage is run in conjunction with Hotel Internationale, Ltd.

Automatic equipment installed in the autosilo selects a parking-box for each car and delivers the car there in about 30 sec. Here's how the system works:

The driver enters the autosilo from either of two sides, and passes a light beam. If the car is above a given height the beam is broken, signalling the need for a large size parking box.

The control officer at the garage office punches into a keyboard the license number of the vehicle and, on the basis of the light signal, the number of an entrance-box. There are 10 entrance boxes—some for high and some for normal cars. The driver runs in his car, releases the hand brake, shifts to neutral if the car has front drive and, as he leaves, presses a "ready" button.

An automatic selector then checks the empty parking-boxes and chooses a suitable one nearest the car. A grab-conveyor pulls the boxed vehicle to a lift tower—the garage includes three such elevators—and, at the end of the elevator ride, drags the car into the selected parking-box.

Simultaneously, teletypewriters at the office print tickets for both the customer and parking records giving date, hour, number of entrance-box, number of parking-box and the car's license number. To retrieve his car, the customer presents his ticket and pays the parking fee; the control-officer presses an "exit" key for the designated parking-box. When a lift servicing that parking-box is free, the automatic selector choses a suitable entrance-box to carry the vehicle to the elevator and ground level.

The conveyor system was designed by Mohr & Federhaff of Mannheim, Germany; the electric control system by Siemens & Halske AG, Munich, and Siemens Elektrizitaterzeugnisse AG, Zurich. The garage has been 3½ yr in construction.

A variety of safety devices protect customers and vehicles. Triple controls insure that elevators do not carry a car that is too long or wide. Audible signals and barriers warn customers away from entrance-boxes while mechanical apparatus is operating. The lifts can be switched to manual operation in emergency.

Grab-conveyor shuttles . . .
a car from entrance-box to a parking-box at 8-story garage in Basle. The vehicle is both parked and retrieved by equipment controlled from an office-based console.

Sputnik III Launched with Single Rocket

"The third Soviet artificial Earth satellite was launched with a single-stage rocket and not a two-stage rocket," writes Soviet Academician Shternfeld in a new book on space machines. The announcement was included in a report on International Geophysical Year information released by the USSR.

Shternfeld's book *Iskusstvenniye Sputniki (Artificial Satellites)*, which is the revised and enlarged second edition of *Iskusstvenniye Sputnik Zemli (Artificial Earth Satellites)* and which contains information on Sputniks I and II, came off the press on Dec. 26, '57, bearing a 1958 publication date. Sputnik III was launched last May 15.

The '68-model Copters May Carry 100 Tons

BONN—Within 10 years helicopters will be able to handle loads up to 100 tons, Igor Sikorsky predicted here at a meeting of the German Helicopter Society attended by top-ranking army officials, engineers, scientists and industrialists. Within five years, Sikorsky added, "flying cranes" will lift loads from 20 to 25 tons.

The famed helicopter designer expects that the major hurdle will be to modify or dispense with the conventional heavy cabin and in its place provide a lightweight rig that will sling the load under the helicopter's body at the true center of gravity. One of the pilot's seats will have to slew through 180° and the copter's controls arranged so the machine can fly backwards with ease. The large machines will probably carry a third man to operate lifting gear.

Helicopters in the future may be used to tow ships or vehicles, Sikorsky said. And he is more than sure that copter companies will be running "house-to-house" services using containers fitted to carry passengers or freight. A full container could be picked up and flown to its destination where a second would be waiting for a lift to another point along the route.

Although he foresees no technical obstacles to 300-passenger copters, Sikorsky believes the idea will not catch on because effective range of the machine will be limited to 175 mi nonstop. He said five 60-seat copters will probably pay off better than a single 300-passenger one, for commercial traffic volume will probably never require such large capacity for short hops.

Long-range helicopters will probably be amphibious, concluded Sikorsky. They could be refueled from tankers at sea or from any normal fueling point on land.

A 7- to 8-ton flying crane currently sells for about $1 million.

'Shame Show' Indicts Japanese Design Pirates

Tokyo—A bold campaign for Japanese originality in design is being waged by the Patent Office branch of the Ministry of International Trade & Industry (MIT). Key weapon at present is an exhibit of 100 Japanese-made products. They are displayed alongside foreign-made originals from which they were copied directly. In some cases the originals and copies are so nearly identical that parts are interchangeable. Also included are examples of steals from fellow designers in Japan.

The Patent Office hopes the display—called a "show of shame" by one official—will goad industrialists to put more time, money and effort into original designs. The office also hopes the display will make the general public realize that "the maker of an original product has the right to its design, and a right to be angry when it is copied." This initial display in a downtown Tokyo department store will be reinforced by similar shows in outlying cities.

In staging the exhibit, Tadashi Takada, Patent Office design section chief, said the government had to buck both domestic wrath and foreign apathy. Takada told local newsmen that some manufacturers threatened reprisals when word of the proposed exhibit got around. And because foreign manufacturers whose designs were "stolen" failed to cooperate, the show includes only a small number of items even though thousands of copied articles are produced in Japan daily.

Behind design piracy lie many cultural, economic and political causes. For one thing, a sense of ownership is new in Japan. The principle of trespassing is less than 100 years old. Japanese understand and respect patent laws, says Takada: "But if it has not been patented, they feel no restrictions. And Westerners must admit that this is a difficult concept at best."

Protection under Japanese patent law poses some difficulties for the foreigner. To get full protection for his product, a manufacturer's patent application must separately cover the product's internal and external engineering design, its function or method of operation, and its industrial design features—both internal and external. After application is filed, the law requires a period of deliberation rather than automatic approval. West Germans and Scandinavians are sharply critical of the delay though the system is similar to that practiced in the US and Britain. Finally, the task of describing a foreign product in Japanese—a language that does not lend itself to business usage—is difficult and has given rise to litigation in the past.

As for the economics of piracy, Nipponese firms are often undercapitalized and operate at profit margins that would seem precariously slender to an American executive. Obviously

"Let's Not Be Copycats" . . .
is theme of Tokyo's anti-piracy design exhibit. It highlights an assortment of Japan-made items that are direct copies of foreign design. Master-minded by Tadashi Takada, of Japan's Patent Office, and laid out with the aid of Sori Yanagi, a leading Japanese designer and former lecturer at Columbia University, the display will move on to Osaka, Kyoto and possibly other cities. Takada is shown in photo at left with Japanese replica of German-designed motorcycle. Among other paired products in the exhibit is a US Bell & Howell projector (center) alongside its identical twin. Bell & Howell, recently denied permission to set up a joint company with its long-time Japanese agent, has protested to the Japanese government. The German Leica and Baby Rolleiflex cameras (foreground) have the same look in Japanese copies below them. Photo at right shows American Shick and Dutch Phillips electric razors alongside Japanese copies.

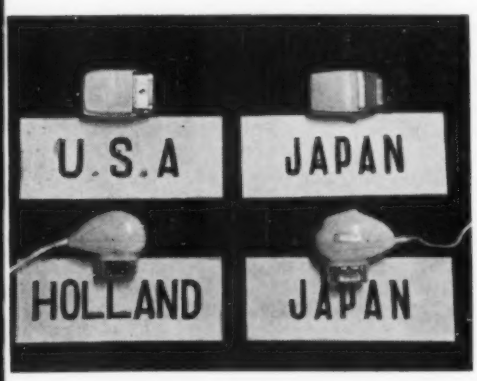
it is difficult to shake R & D money from empty company coffers. Some firms are getting a boost from the West by licensing and royalty agreements. Recently a movement has emerged among firms in export trade to pool resources for joint support of research ventures.

American importers, too, have sometimes encouraged piracy. Some postwar buyers are "not first-class businessmen," says Takada. He contends they are interested only in fast profits, and will give a Japanese manufacturer a production order with a guarantee to buy a stated quantity if the Japanese can produce copies that look like the foreign original.

Many forces today are deflecting Japan from the role of design imitator, and these will likely be amplified by the shows. Various industrialists here are shifting to production of heavy industrial equipment. This equipment must be designed for competitive markets. Much will go to underdeveloped nations with special needs that cannot be met by design piracy.

In the postwar period Japanese have scored some startling sales triumphs through good indigenous design—cameras and dinnerware, for example. These successes are building confidence. And Nippon has a culture with a rich heritage of art and design which offers many new ideas.

Perhaps strongest deterrent to imitation is the sense of shame building up in Japanese youth and fanned by "shame shows." A government official observing the piracy exhibit pointed to a group of uniformed school children and expressed the cautious hope: "They attend an industrial high school, and many of them will be designers—designers who won't copy foreign designs—maybe."



Seek Better Truck-brake Design

WASHINGTON—A sizable chunk of business, in the form of better brakes for big tractor-trailer truck combinations, may be rolling right by designers. There are close to one million of these trucks on the roads.

Nationwide road-checks conducted by the Interstate Commerce Commission repeatedly show that many of the vehicles inspected have defective braking systems. This means the trucks have to be pulled off the highway until deficiencies are corrected. A loss of time and money to the truck operator—but the ICC action is necessary for the safety of motorists.

Although these road-checks show a high percentage with bad brakes, this does not mean that these trucks are uniformly a highway safety hazard. In its inspections, the ICC admittedly concentrates on trucks that appear to be in poor condition.

Nonetheless, during last May's most recent road-check, some 9,308 vehicles were inspected and 20.6% ordered "out of service" for one reason or another. The ICC reports states that, "of all units (a tractor and trailer are counted as separate units) taken out of service, 91½% had serious defects of some part of the brake system."

DESIGN?—OR MAINTENANCE?

Just how much of the brake faultiness can be pegged to poor design and how much to bad maintenance is highly controversial. There is no question but that present braking systems would perform properly if they received top-notch upkeep. But some truck operators counter that a lot of this maintenance could be designed out of the brakes.

The ICC requires that all trucks be equipped with two braking systems, parking and service. Combination tractor-trailers must have two, independent, service braking systems—one for the tractor, one for the trailer. This is a safety measure against the vehicle's going out of control if one unit's brakes conk out.

Service brakes are conventionally a type of air or vacuum brakes, or combination of air and hydraulic. The parking brakes must be mechanical, using a ratchet-and-pawl device. The major share of defects is found in the control system of air lines and valves that actuate the foundation brake drums, shoes, chamber, etc., on the service brakes. Primarily, these troubles are air leaks, worn hoses, and defective diaphragms in the brake cylinders.

Most criticism is directed at the control system. Although there are numerous adaptations of brakes on the market, it has been years since any really basis change has been made, say some truck operators.

This doesn't mean the trucking industry is anxious and waiting to have a new braking system handed to it. Traditionally, the industry is reluctant to make changes. And any new system would have to meet stringent requirements before it would be adopted.

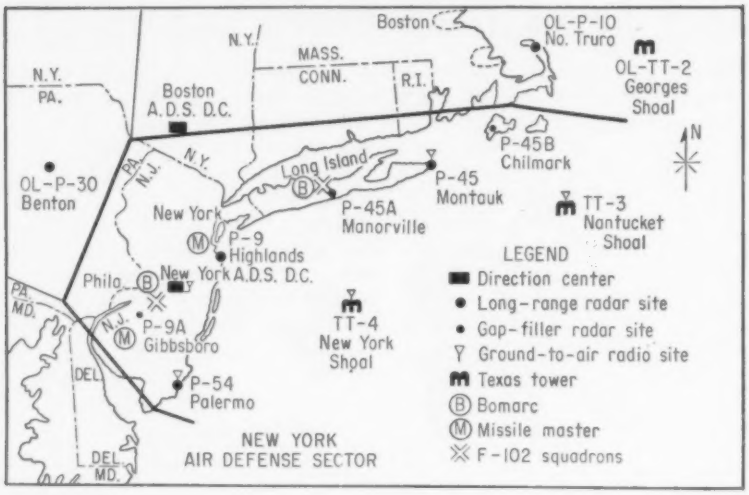
Paramount need is to meet all the ICC safety regulations. But, just as important, the brakes must fit into a narrow price range. Truckers operate on slim margins and say they can't afford expensive equipment outlays that don't lead to ultimate economy. Also, the interchanging of trailers between truckers is a common and growing practice—and any new braking system should meet this operation requirement.

NEW DESIGN CAN HELP

But there is still room for design work. It lies, say the operators, in building a system that does not require extensive maintenance. The degree of maintenance given truck equipment varies with each fleet. Some keep their trucks in A-1 shape; others are negligent. But, maintenance work is time-consuming and expensive for the operators.

Equipment that breaks down, for lack of maintenance or other reasons, is costly. Not only does it mean a loss of time to the operator, it means thousands of dollars worth of shipped cargo is often delayed. If the shipment consists of perishable foods, it may be ruined.

Safety worries the truckers too. Since their business keeps them on the highways most of the time, they are just as concerned as the next motorist with preventing accidents. Mile for mile of driving, trucks are the safest vehicles on the roads, and if better braking systems can improve this record; truck owners are all for it.



Air coverage . . .
of sector shown bounded by heavy black lines is controlled by Direction Center at McGuire Base. Defensive equipment under its control includes fighter squadrons and Bomarc unmanned missiles based at two air strips. The Missilemasters (M) control, between them, about 35 individual Nike installations around the area.

First Sector of SAGE System Now Operating

McGuire Air Force Base, N. J.—The first sector of SAGE—Semi-Automatic Ground Environment System—has officially gone into operation here. One part of a complex nationwide air-defense network, this New York sector is first of 29 being established around boundaries of the US. Total cost of the system when complete has been estimated at from $7-8 billion.

Because SAGE's radar warning network extends but a few hundred miles from the coast, it can only give adequate defense against air-breathing planes and missiles in the Mach 1-1.5 speed range. This is regarded as the greatest threat to the US in the next few years. However, Gen. Earle Partridge, head of the North American Defense Command, says that with the improved radar soon to be available, and other countermeasures, SAGE might be adapted to an anti-missile system for protection against ballistic missiles like ICBM's.

Elements of SAGE are: (1) long-range-search radar units on strategic ground sites as well as on the Texas Towers about one hundred miles off the Atlantic Coast; (2) gap-filler, unattended radar units that plug holes left at the curvature of the earth by the large radar; (3) airborne radar-equipped Super Constellations which patrol beyond range of the Texas Towers; (4) radar-equipped Navy picket vessels.

All these units feed back data to a Direction Center, via telephone lines or microwave radio, where an input system translates the information for computer use. When range, speed, direction, etc., of the attacking aircraft are determined, the human element comes into play to decide whether to use the Nike or Bomarc missiles, or to alert squadrons of F-102s, F-104s, or F-106s.

The IBM computer at the huge center here is actually two computers. To supply information 24 hr a day, 7 days a week, one computer is on the line while the other receives necessary maintenance. The latter, however, is continually monitoring information of the working computer and can take over if necessary.

Three other radar networks feed information into SAGE: the Pine Tree Line which overlaps into Canada; the Mid-Canada Line that stretches from British Columbia to Newfoundland; and the DEW (Distant Early Warning) Line extending across the top of Alaska and Canada.

The massive, windowless, 4-story-high blockhouse here known as the Direction Center was considered first as an underground installation, and may well become one someday if computer complexes get smaller. Transistorized units probably will be installed in the last few of the Direction Centers.

Present phase of the SAGE contract was completed by joint effort of 79 major Air Force agencies, 65 prime contractors and 150 telephone systems. Telephone lines carry bulk of the radar data after it has been converted for transmission by wire. Estimate of the entire annual maintenance bill for the SAGE system is $\$1\frac{1}{2}$ billion.

Russians Not Far Behind in Plastics

New York—Russian plastics and chemical plants are producing most of the things we are, says T. J. Kinsella, president of the Plastics and Coal Chemicals Div. of Allied Chemical Corp., just returned from a $3\frac{1}{2}$ week visit of Russian plastic and chemical plants.

Where they do not have large commercial plants, as in the case of linear polyethylene and synthetic fibers, they are producing in sizable semicommercial pilot plants. In compression molding of conventional plastics, such as phenol-formaldehyde and polystyrene, they are surely equal to the US. Kinsella added that injection molding appears to be slow, probably at half the rate in this country; also the quality of the laminated plastics was poor.

Toys and items of household use, normally made from vinyls and polyethlene in this country, are being produced on a large scale in Russia from celluloid and acetate. According to Kinsella, lack of materials handling equipment slows up operations in most plastics plants.

At the Polymer Research Institute in Leningrad, he found emphasis placed on fluorine plastics and copolymers. Much progress has been made in the development of high temperature plastics, as well as low-cost synthetic fibers and "natural" synthetic rubber.

Kinsella said the Russians indicated again and again that, while nylon, Dacron and Orlon type fibers were fine, they need something cheaper, and are anxious to buy the know-how from other countries.

USSR Gains in Vibration Casting

VIENNA, AUSTRIA—The application of supersonic vibrations during the pouring and solidification of castings (*PE —Nov. 11, '57, p. 115*) was main topic of discussion at a conference at Kiev held by the Institute of Metallophysics of the Ukrainian Academy of Sciences, and a scientific and technical society of the tool producing industry. Well attended by Russian scientists and engineers, the conference heard 16 papers pointing out progress in supersonic techniques.

According to reports in the US, it is impossible to effectively utilize supersonic vibrations (25,000-250,000 cps) in metal vibrating-casting techniques because of large power requirements. About 75 kw per ton of metal has been estimated. Furthermore, it has not been possible to reproduce the results obtained by this technique in parts of any significant size.

Several manufacturers in the US are using controlled frequency vibration to improve grain structures on large castings, but frequency has been from 12,000 to 24,000 cycles per minute and with irregular waveform less than 0.01 in. in amplitude.

To get around the problems associated with supersonic range, a vibratory casting technique in the sonic range has been suggested which uses two simultaneously imposed frequencies. Ideally, the mass should be air-suspended. Vertical vibration is from 1,000 to 20,000 cpm. Superimposed vibration is at right angles to it with frequencies 10 times the vertical. Power estimates are about 2-5 kw per ton of metal, and the results are reproducible. With this method it is possible to get rid of segregation, slag and gases at 3,000 cpm, with good grain size in carbon steel at 10,000 cpm.

Lashing paperboard . . .
to a tank's underside absorbs shock from an airdrop and permits safe descent at 45 to 55 fps with greatly increased accuracy. An experimental platform developed by the US Army QM Corps, the honeycomb shock absorber is combat-expendable. It is made of lumber, plywood, and paperboard. Cost is about one-tenth and weight is ½ that of present gear. The platform can be fabricated on the spot in a few hours to fit individual equipment.

Easier Test Found for Abrasion Resistance

ROCHESTER—A new method for determining the wet adherence of supported films to various bases has been developed by Arthur S. Diamond of Kodak Research Laboratories. It provides a simple and precise means of measuring wet adherence or abrasion resistance of various coatings.

Diamond said that while the technique has so far been used only with emulsions applied to photographic film and paper, it could also be valuable in measuring a variety of coating materials and coated products such as paints, organic coatings, protective and decorative papers, plastics and textiles.

He explained that his method employs a pebble mill, charged with a specified amount of pebbles and fine quartz abrasive carried in water. A certain number of exposed film or paper samples are abraded in the mill for several minutes, then placed in an optical densitometer to determine photometrically the percent of emulsion area removed. This "coefficient of abrasion" is a measure of the sample's wet abrasion resistance.

Diamond pointed out major advantages of the test. It provides a numerical rating based upon a physical measurement. Sensitivity can be varied readily by altering one or more of the mill conditions such as milling time, liquid volume, or amount of abrasive charged.

Diamond noted the test conditions can be easily standardized and operator variability virtually eliminated. He said only a small sample is required, and the test can be performed quickly.

Bits and Pieces

Instruments designed to get better information on strength, durability and dimensional stability of structural materials are expected from three Bureau of Standards research assignments. The projects, aimed at improving and developing new strain gages, cover improvement of ceramic-bonded gages, development of strain-sensitive evaporated film gages, and evaluation and calibration of current and proposed strain-measuring devices. . . . Amplex Div., Chrysler, has installed a 300-ton-capacity production press for powdered metal parts. It is capable of turning out parts up to 30 in. dia and adaptable to quantity production runs.

Electricite de France plans a third nuclear power plant. The proposed reactor will produce 150,000 kw at a site near the Franco-Belgian border. The plant will join two reactors totaling 160,000-kw in the Loire Valley and a 50,000-kw reactor at Marcoule in the south of France now under construction. France's anticipated 850,000-kw nuclear generating facilities in 1965 compare with US projected 1,300,000 kw capacity by 1964.

A coating film that promises to keep jet engine ball bearings operating several hours after the lubrication system fails has been announced by New Departure Div., General Motors. Describing test results, GM engineers say bearings with 30-mm bore were run at 7000 rpm, with 75-lb thrust and 25-lb radial force applied in an environment of 500 F for 10 hr. No lubricant was added, yet bearing parts showed no major damage. . . .

More Servo Design in Chemical Industry

PHILADELPHIA—Systems engineering and automatic process control through servomechanism design methods are beginning to exert an appreciable impact on operations of the chemical manufacturing industries, Dr. Theodore J. Williams told the American Institute of Chemical Engineers.

In a paper on "Organization for

chemical process control," which he co-authored with Dr. Joel O. Hougen, Dr. Williams pointed out that even though the concepts referred to have been well proven by their applications to the aircraft, electronics and other defense industries for the past several years, there has been a lag in information transfer to the chemical industry.

This lag, the authors believe, can be attributed to chemical companies lacking personnel with the proper training and experience to initiate studies in this field. He cited also a lack of availability in the chemical industry of the required equipment, such as large-scale analog and digital computers, to carry out the studies.

The authors reviewed the basic relationship of these newer concepts to the previously standard chemical engineering methods and detailed work to be done in the field. In addition, they suggested an industrial organizational structure and described training and equipment necessary for progressive work in the field.

COMING EVENTS

AUGUST

6-8 . . . . American Institute of Electrical Engineers, Special Technical Conference on Non-linear Magnetics and Magnetic Amplifiers, Hotel Statler, Los Angeles.

11-14 . . . . Society of Automotive Engineers, National West Coast Meeting, The Ambassador, Los Angeles.

13-15 . . . . American Institute of Electrical Engineers, Institute of Radio Engineers, National Bureau of Standards, Conference on Electronic Standards and Measurements, NBS Boulder (Colo.) Labs.

18-21 . . . . American Society of Mechanical Engineers, American Institute of Chemical Engineers, Joint Heat Transfer Conference, Northwestern, Evanston, Ill.

19-22 . . . . Western Electronic Show and Convention, Pan Pacific Auditorium, Los Angeles.

SEPTEMBER

1-7 . . . . International Association for Analog Computations, Second International Conference for Analog Computations, Strasbourg, France.

11-14 . . . . Society of Automotive Engineers, National Farm, Construction and Industrial Machinery Meeting, Production Forum and Display, Milwaukee, Wis.

READER TO EDITOR

Bring Back a Sane Car

To the Editor:

In 1942 or thereabouts, Ford had a "5 in line" engine that with 5 crank throws was smoother than a V8. Many of us confidently expected the return of the "Model A" in modern styling. Instead, year after year, each of the "low-priced three" grew bigger and more powerful until now we only have the "Fordalac," "Chevalac" and "Plymalac," all of which cost nearly as much to purchase as their namesake but none of which gives the economy of operation of their benefactor.

Benefactor?—I wonder, for as soon as the industrial spies reported four headlights were on the drafting boards of Cadillac every manufacturer converted, and now the "4-eyed monsters stand row on row," mostly on dealers' lots. I need 4 headlights like I need a hole in the head, or 14 head and tail lights (Chevy) of 44 lb of chrome (Olds) or 2-story fins (Chrysler) or 200-cp tail lights (Pontiac, Ford, etc.) that blind cars in the rear, or autos that can only give you gasoline mileage economy in *ton-miles*.

Then too, in stretching their models, "longer, bigger, roomier and whopperier," they also stretched the metal until now, 7- and 8-month mufflers are commonplace and protective coatings grow thinner and thinner while rusty bumpers and metal are a common sight on $3000 automobiles not 6 months old. ("It's the salt on the streets, you know.") To make up for poor design in front-end geometry, power steering was given us. ("To help you park in tight places") yes, and just so you can steer that 4000-lb blunderbus.

Formerly trading every year, I'm hanging onto my 1956 car. It's one of the last sane years in car design and when its chugged its last— then I'll retreat to one of the foreign models noted for their reliability and economy.

—B. Carrier
Peterson Mfg. Corp.
Fundale, Mich.

To the Editor:

I don't care how many fat cars they make, as long as I can buy what I want. I am now driving a Metropolitan and feel quite happy—I feel that at last I am driving something I can afford, a poor man's car, I call it. My wife hates to shift gears and drives the big one—after all, men drive cars, women wear them.

—*Name Withheld*

In Defense of the Salesman

To the Editor:

Why the very unnecessary and very unfair crack at salesmen in your April 21 issue (p. 35)? The article by Irwin Sharpe is an unfair, emotional, opinionated presentation.

If Mr. Sharpe would take time out to talk with operating, design and purchasing engineers, he would find that for the most part they consider the good industrial salesman very valuable. His close observation of activity in a number of plants can save them many wasted hours.

Good salesmen are not insulated from the customer even when they sell through distributors and wholesalers, and I think that Mr. Sharpe is taking a very loose interpretation when he quotes the National Industrial Conference Board in what he says is a summation of, "the case against the salesman." If he reads this closely, he will note that it says, "salesmen *may* misjudge the extent of the market", and "are *frequently* unaware of the technical problems." The NICB is offering nothing more than a natural caution, not making any case against the use of sales people.

This is not a plea for following intuitive or fact-based recommendations from salesmen, but I object very strongly to a one-sided approach which leaves the idea that salesmen are "emotional, enthusiastic" men with, "memories limited to last week's lost sale." Creating a new product is a job for a team and the sales members of this team are extremely important . . . to ignore them or play down their value is foolhardy. —George Black
Sprout, Waldron & Co., Inc.
Muncy, Penna.

• Mr. Black apparently did not notice our cover comparison or the editorial in the same issue. The latter took a point of view diametrically opposed to that of Mr. Sharpe. Our attitude is, to quote Voltaire, "I disapprove of what you say, but will defend to the death your right to say it."—E. J. T.

first in silicones

Dow Corning

SILICONE NEWS

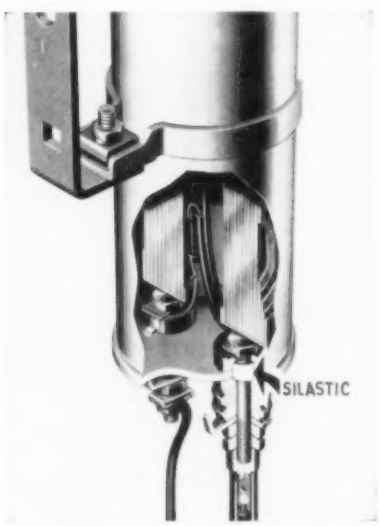
for design and development engineers • No. 52

How to Design for Minimum Maintenance

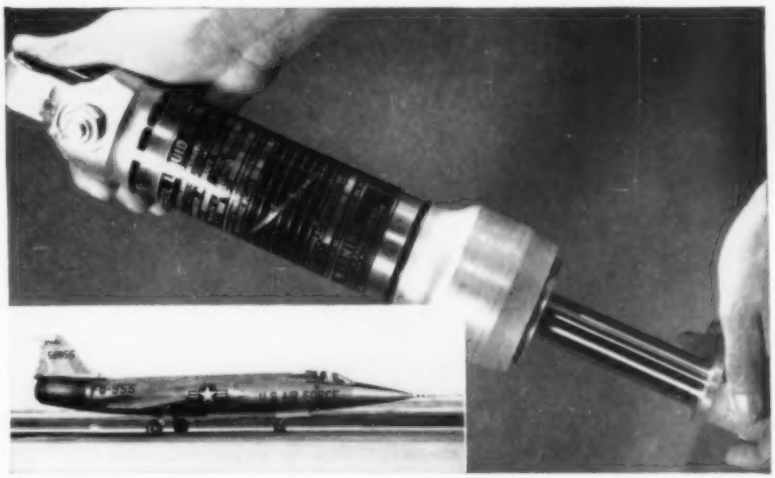
You get a positive maintenance-free seal with Silastic®, the Dow Corning silicone rubber, because it stays resilient over a wide range of temperatures and resists weathering and reactive fluids. That's why Westinghouse engineers specified Silastic in designing for minimum maintenance.

Silastic is the only rubbery material that remains resilient enough to maintain a tight seal over a temperature span stretching from —130 to 500 F. It won't harden or crack when exposed to weather and corrosive atmospheres, and it has excellent resistance to a variety of fuels, oils and chemicals. These are a few of the properties which have led to Silastic's growing use as a gasketing and sealing material in the aircraft, automotive, appliance, electrical and process industries.

The new Westinghouse line of secondary capacitors may be mounted with the terminals positioned either up or down. The units feature lightweight extruded aluminum cases terminally-sealed with Silastic sleeve gaskets. Fitted around the terminal



studs, the sleeves extend into recesses in the exterior porcelain insulators and the interior Micarta bushings. When the assembly is tightened, the Silastic is compressed to form a permanently tight seal. The seal retains its resilience (Cont. Pg. 2)



DESIGN SMALLER SHOCK ABSORBERS WITH NEW COMPRESSIBLE FLUIDS

Here's how a compressible silicone fluid enabled Cleveland Pneumatic Tool Company to substantially reduce the size and weight of aircraft landing gear shock absorbers. This design provides a good illustration of the reason why silicone fluids are finding growing use as damping, springing and driving media.

Developed for the Lockheed F-104 Starfighter, the new Cleveland Pneumatic "liquid spring" boasts a 30% smaller oil chamber than shock absorbers that depend on organic fluids. The reason: the Dow Corning silicone fluid is 30% more compressible than standard MIL-O-5606 oil. With the silicone fluid's compressibility (14% at 40,000 psi), it takes only 26 cubic inches of fluid per unit to efficiently cushion each of the main landing wheels.

In addition, the silicone fluid's inherent lubricity and resistance to oxidation keep maintenance to a minimum. The new shock absorbers are expected to give years of satisfactory service without requiring special attention.

OTHER FACTS about Dow Corning silicone fluids: (1) Serviceable from —100 to 400 F; (2) Available in many viscosities; (3) Show little change in damping or torque-transmitting properties despite extreme temperature variations; (4) Are highly resistant to oxidation and to viscosity break-down due to shear. *No. 526*

New Adhesive Bonds Silicone Rubber Faster, Better

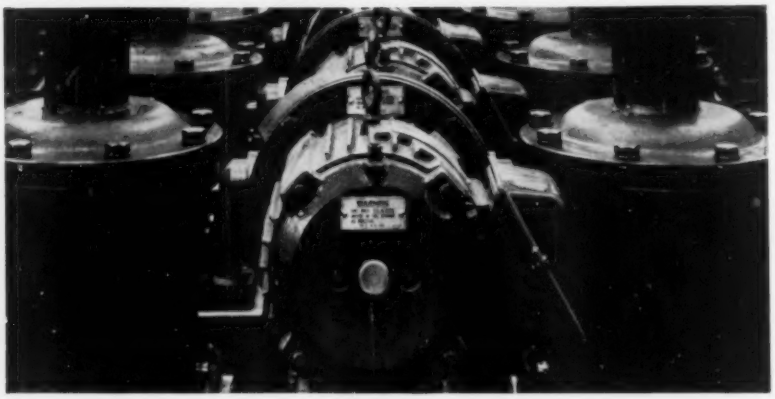
Now you can get a strong, durable bond between silicone rubber and metal surfaces. You can also use the same Silastic® adhesive to bond silicone rubber to itself.

Silastic Adhesive S-2200 promises to provide an ideal solution to a variety of splicing, gasket-sealing, blanket-mending and duct-lining problems. This solvent-free adhesive cures in minutes and is serviceable over a wide temperature span. Tensile tests indicate that the cured bond withstands 25 pounds pull per inch width and retains full resilience and mechanical strength from —70 to 500 F.

Silastic S-2200 is translucent, nontoxic, contains no solvent, has excellent shelf life and may be applied with a knife or spatula. Vulcanized at 240 to 270 F, it creates a strong bond with (Cont. Pg. 2)

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE



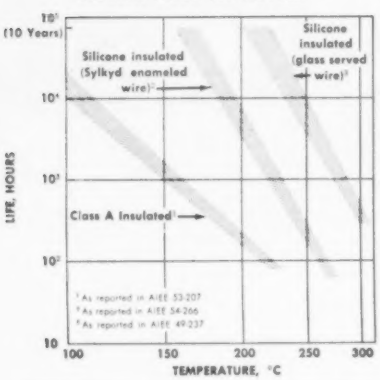
ASSURE MOTOR RELIABILITY WITH SILICONE INSULATION

Typical of the progressive design thinking reflected in the new Harvey Aluminum smelting plant at The Dalles, Oregon, are the anode feed motors in the electrolytic section. Wanting to take no chances on the reliability of motors performing this vital function, Harvey engineers specified Dow Corning silicone insulation for all 960 of them.

Used in the reduction plant to feed carbon anodes into electrolytic cells, all 960 electric motors are subjected to ambient temperatures in the order of 300 F. Silicone insulation was selected because it has many times the life expectancy of other insulating materials under comparable conditions. When operating intermittently to adjust electrode level, these two and three horsepower motors insulated with Dow Corning Silicones have more than enough thermal stability to assure reliability despite the combined heat of high ambient and motor load.

Reliance Electric & Engineering Co., Cleveland, designed and built these motors to Harvey specifications. Experience in hundreds of plants has demonstrated over and over again that silicone insulation quickly pays for itself in reduced replacement, repair and maintenance costs. *No. 527*

LIFE EXPECTANCY OF CLASS A AND SILICONE INSULATED MOTORS



ADHESIVES *(Continued)*

silicone rubber in 5 minutes. Optimum adhesion to metal is developed by a 4-hour cure at 480 F. A good bond is obtained with a shorter cure by using the recommended air-drying primer. Because the adhesive is solvent-free, parts can be stuck together immediately after applying Silastic S-2200. *No. 529*

SILASTIC *(Continued)*

despite prolonged exposure to a wide range of outdoor temperatures, thus making the unit virtually maintenance free. The seals are also resistant to Inerteen, the high-dielectric but relatively reactive fluid especially developed by Westinghouse for capacitors. *No. 528*

new literature and technical data on silicones

Thermal Evaluation of Electrical Insulation as a Design Tool, an eight-page reprint from ELECTRICAL MANUFACTURING, points to solutions for meeting the problems of increasingly severe performance requirements. *No. 530*

First Availability. The only available specially prepared engineer's guide to selecting silicone fluids for reliable, uniform performance in viscous damping, springing, coupling and related mechanical applications. Published as a design service by Dow Corning, this file size guide has been called a "must" reference work for advance development research engineers. *No. 531*

Protective Finishes and Maintenance Paints, made with Dow Corning Silicones, are available from more than 50 formulators listed in a 4-page brochure that describes how these heat, moisture, and oxidation resistant coatings improve product finishing and reduce maintenance costs. *No. 532*

How to Select Silicone Insulating Components is the subject of a new six-page brochure that cites the practical advantages of silicone insulating components and the various materials used in manufacture. *No. 533*

Encapsulating Electrical and Electronic Parts with heat-stable silicone rubber that cures at room temperature is detailed in a recently published data sheet. *No. 534*

Dow Corning Silicone Compounds, for dielectric applications, for release of plastic and rubber moldings, and for protecting finely machined thread parts, are described and compared in a handy reference pamphlet. *No. 535*

More Muscles for Tomorrow, a full color-sound movie, lets you see for yourself the benefits of silicone electrical insulation — increased production, reduced maintenance, freedom from overmotoring and savings in space and weight. Get a folder explaining how to arrange for a showing by circling ---------- *No. 536*

Silastic RTV is a do-it-yourself silicone rubber that vulcanizes at room temperature. It enables you to make rubber parts on-the-spot for those applications where a heat cure is impractical or cannot be tolerated. Silastic RTV retains good physical and dielectric properties. *No. 537*

Dow Corning Corporation, Dept. 867, Midland, Michigan

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SILICONE NEWS published for design and development engineers

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

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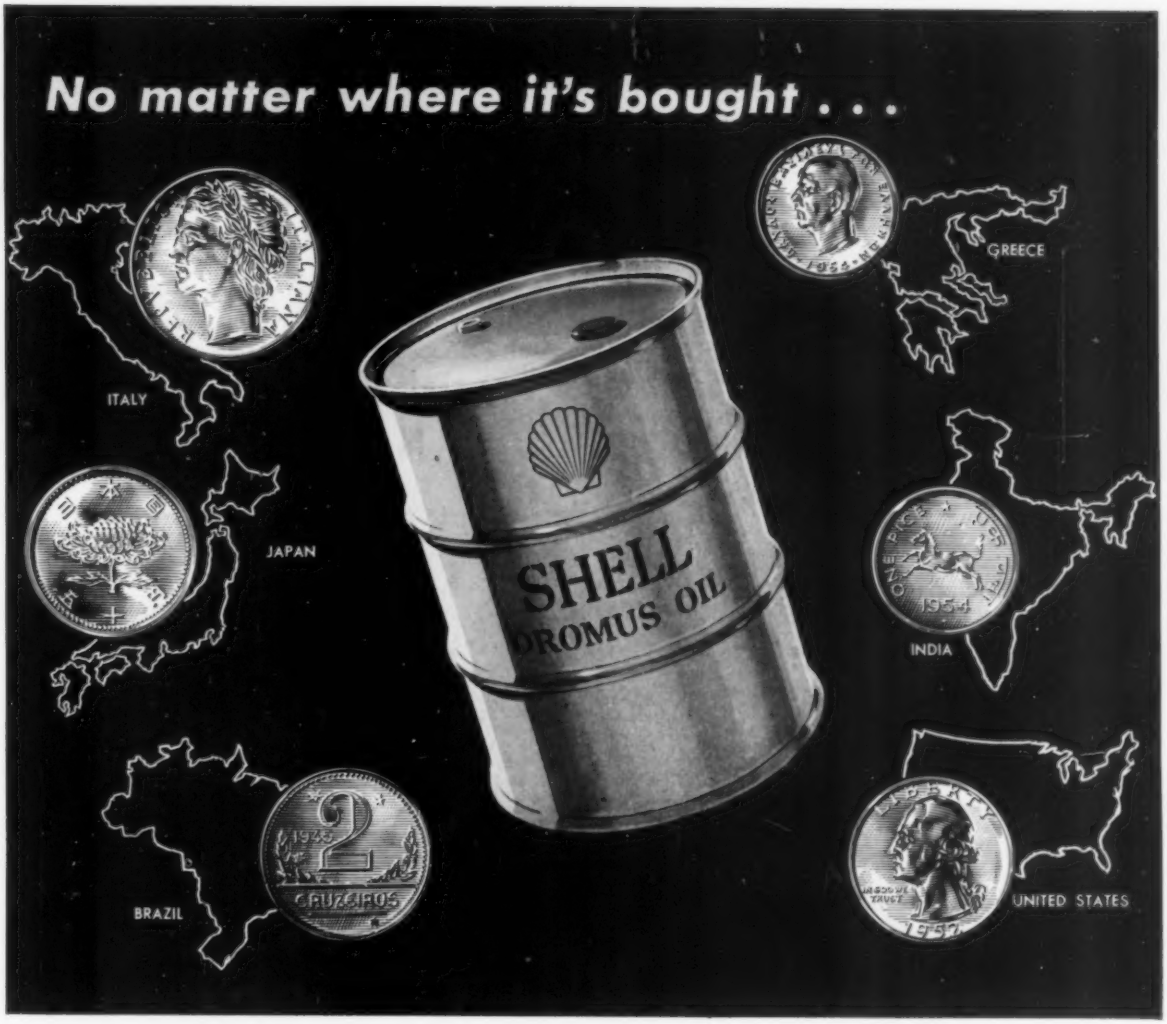

Its performance and name are the same around the world

Shell Dromus Oils are a quality line of soluble cutting oils that permit higher speeds and greater feeds while extending tool life. They have excellent wetting and cooling properties and are not sticky or greasy.

Dromus* Oils have the added advantage of being easy to mix in hot or cold, hard or soft water. They form emulsions which remain stable in any concentration required in the shop.

When your machine tool customers abroad specify Dromus Oil, they will enjoy the same efficient performance your domestic customers rely upon.

For more information, write Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California.

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Quality Engineered

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with Extras . . . at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. IMMEDIATE SHIPMENT in a wide range of styles and capacities, with 64,000 combinations. Write for Bulletin SM 155-3 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

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If your plans demand the best bronze, specify Federated Engineered Bronze *by name!*

As you know, the truly engineered bronzes—silicon, aluminum, and manganese—offer combinations of properties not available in other metals. Federated's extensive facilities deliver the precise qualities wanted. Continual controls during alloying under the direction of metallurgical specialists, assure performance that always meets, often exceeds, specifications. Call one of Federated's 21 sales offices for information about Federated Engineered Bronzes, conveniently produced in Los Angeles, Whiting, (Ind.), Perth Amboy, (N. J.), San Francisco, Houston. Federated Metals Division, 120 Broadway, New York 5. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

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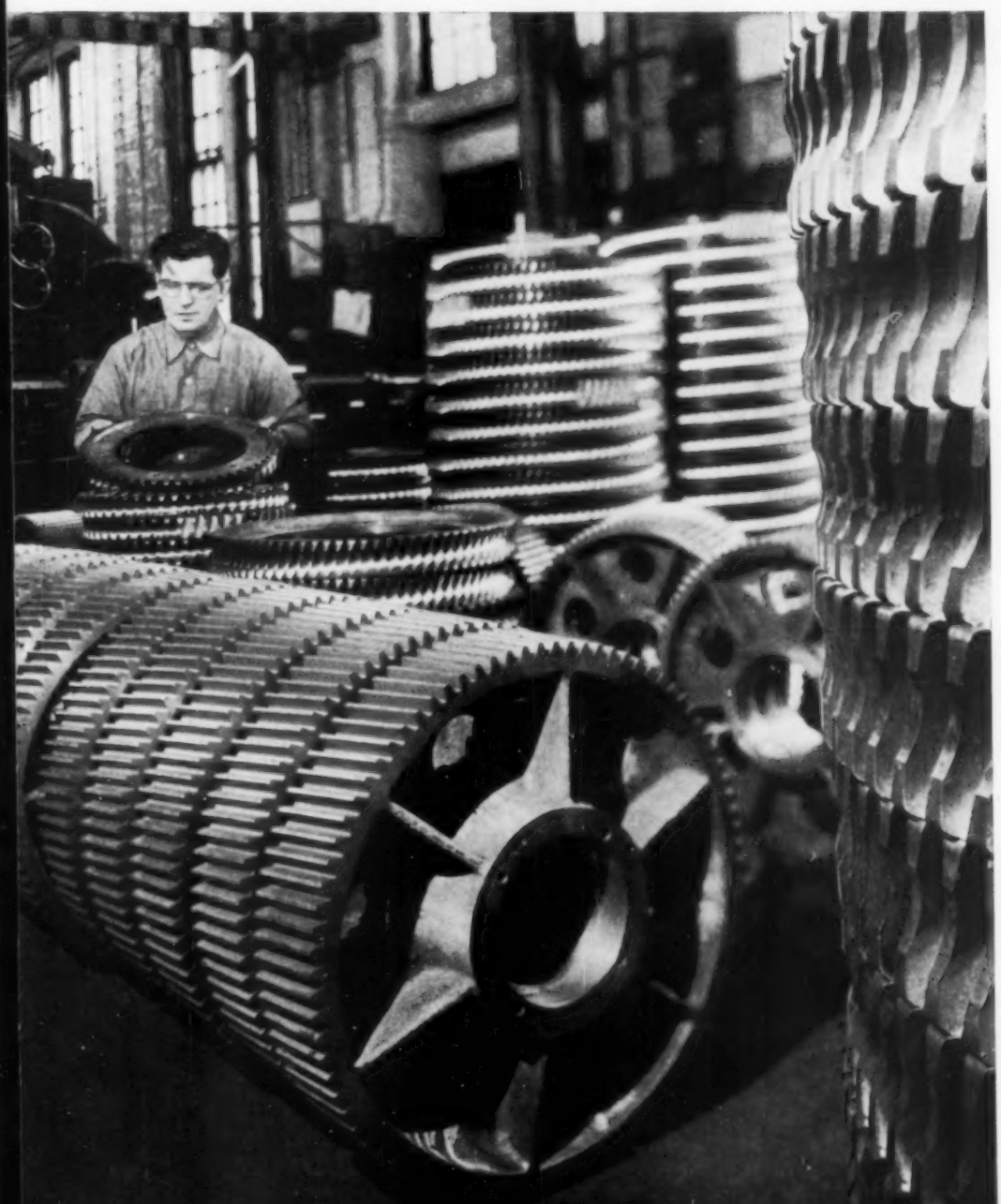


ASARCO

AMERICAN SMELTING AND REFINING COMPANY

Why automotive manufacturers prefer N-A-X® FINEGRAIN STEEL for bumpers

WIDE RANGE OF SHAPES AND CONTOURS
The complexity of today's automotive bumpers demands a steel that provides maximum strength plus unlimited shape and contour possibilities.

FLAT POLISHES TO A HIGH LUSTER
The hardness and fine grain of N-A-X FINEGRAIN renders this steel capable of assuming a high degree of luster at minimum cost.

REDUCES POLISHING COSTS
Bumpers made of polished N-A-X FINEGRAIN suffer no surface disturbances due to coarse grain or strain caused by the drawing process. Preparation costs before plating are thereby reduced.

LESS OVERHANG WEIGHT
Generally, the most difficult bumpers can be made of N-A-X FINEGRAIN with a minimum of 25% increased yield strength over mild carbon steel. This makes possible greater resistance to indentation and substantially decreased overhang weight.

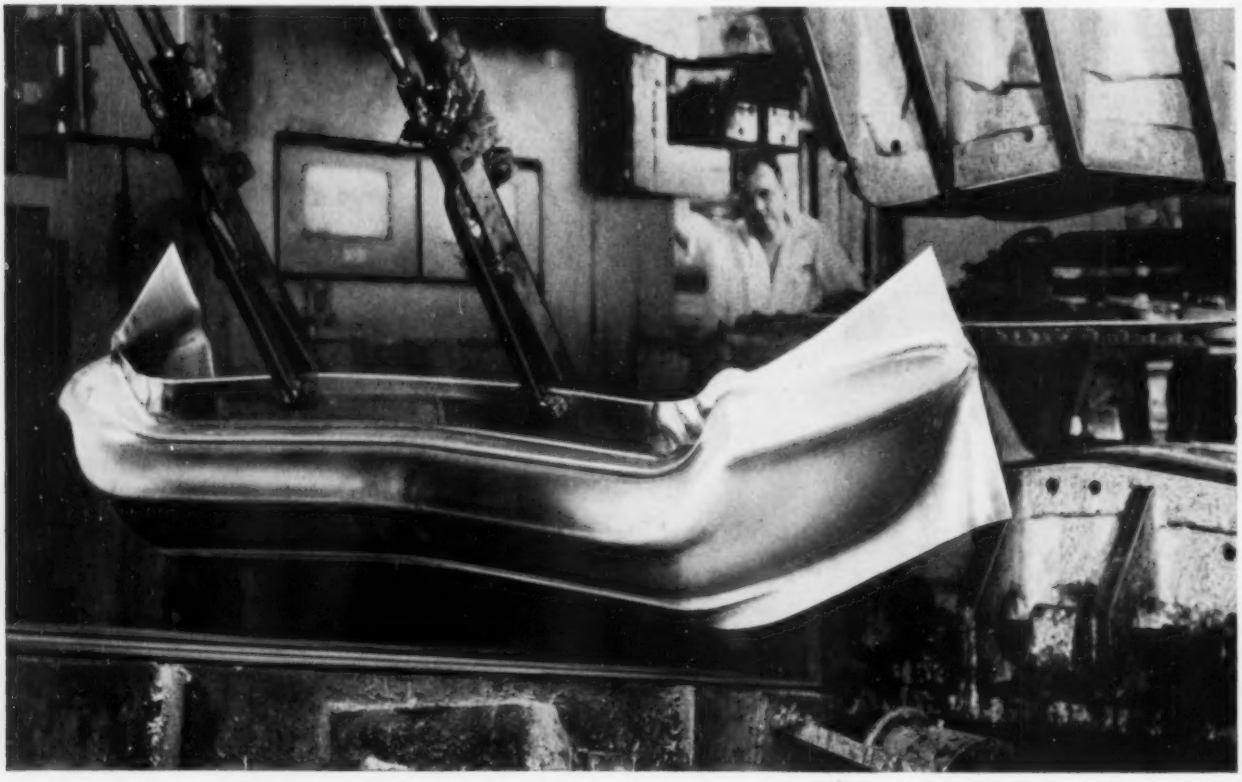
No wonder automotive manufacturers prefer dependable N-A-X FINEGRAIN for the difficult jobs.

CHECK THESE IMPORTANT ADVANTAGES FOR YOUR JOB:
N-A-X HIGH-STRENGTH steels—both N-A-X HIGH-TENSILE and N-A-X FINEGRAIN—compared with carbon steel, up to 50% stronger • have high fatigue life with great toughness • are cold formed readily into difficult stampings • are stable against aging • have greater resistance to abrasion • are readily welded by any process • offer greater paint adhesion • polish to a high luster at minimum cost.

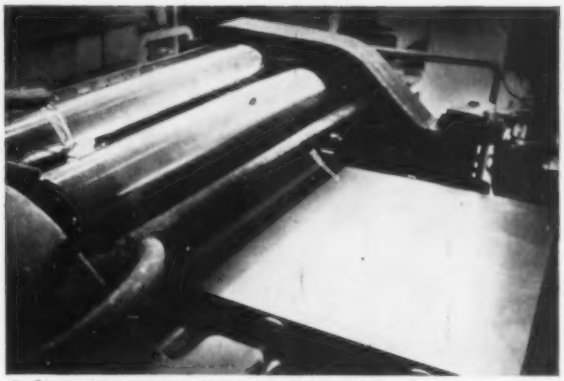
Although N-A-X FINEGRAIN'S resistance to normal atmospheric corrosion is twice that of carbon steel, N-A-X HIGH-TENSILE is recommended where resistance to extreme atmospheric corrosion is important.

For whatever you make, from steel boats to steel bumpers, with N-A-X HIGH-STRENGTH steels you can design longer life, and/or less weight and economy into your products. Let us show you how.

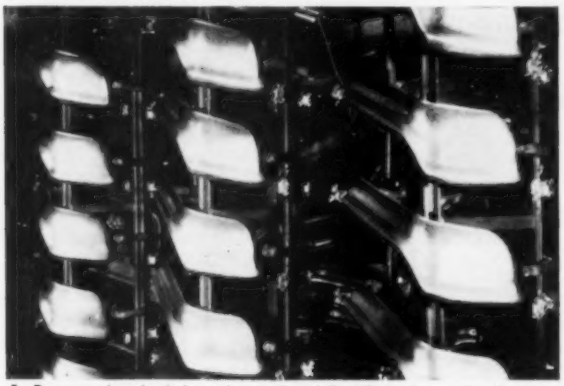
3 Bumper wings, drawn double from N-A-X FINEGRAIN, emerge from press. After splitting and trimming, the protective draw coating is removed. Contoured bumper is then ready for plating without subsequent polishing.



1 Hot rolled N-A-X FINEGRAIN sheets come out of flat polish with a finish of less than 10 microinches.

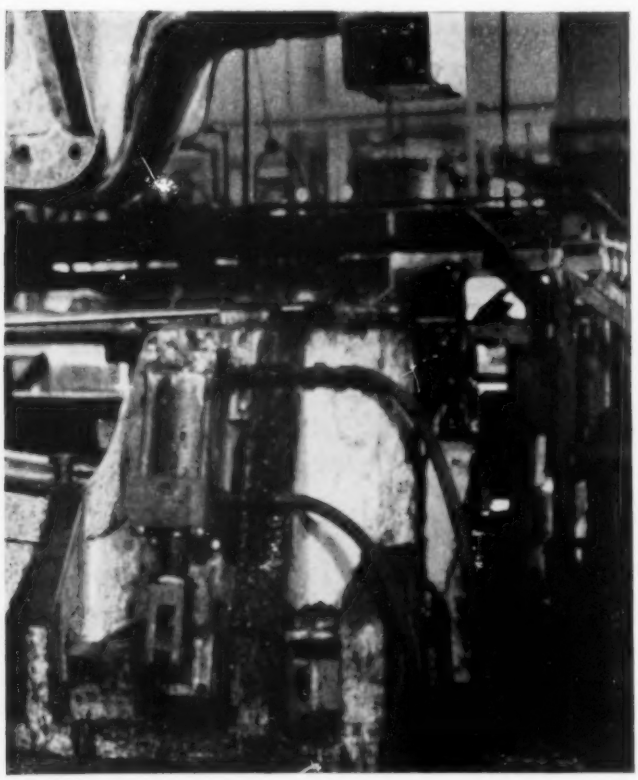


2 Sheet with protective phosphate and draw coatings comes from coating machine ready for the draw press.



4 Bumper wings loaded on elevator for plating. Protective coating has been removed. Note no surface disturbances occurred after drawing operation.

5 Final inspection after plating. No expensive hand-polishing was required from original flat polish to plating operation.



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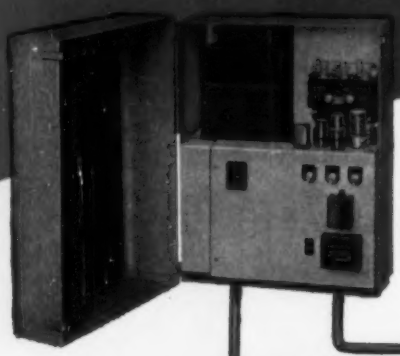
DYNAMATIC®

Drive Package Provides Infinitely Adjustable Speeds from AC Power Source



CONTROL PANEL

CONTROL STATION

The complete Dynamatic power package includes all components required to provide infinitely adjustable speeds from an alternating current power source. A Dynamatic Ajusto-Spede® or Dynaspede® Drive, with electronic control and pushbutton station, satisfies the requirements of almost any application where proper machine operation or material processing depends upon control of operating speeds.

The compact control panel may be remotely mounted to conserve valuable space on the driven machine. The pushbutton station at the operator's position puts vital controls conveniently at the operator's fingertips and requires a minimum of space.

Speeds are infinitely adjustable from 0 RPM to full output speed, and accurate speed regulation may be obtained from 100 RPM to full output speed.

Ajusto-Spede® Drives, available in ratings of ¼ horsepower to 75 horsepower, are air-cooled. Dynaspede® Drives, rated from 3 to 75 horsepower, are liquid-cooled. Raise your productive efficiency with Dynamatic eddy-current units.

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AJUSTO-SPEDE DRIVE

Send for Illustrated Literature Describing Dynamatic Adjustable Speed Drives

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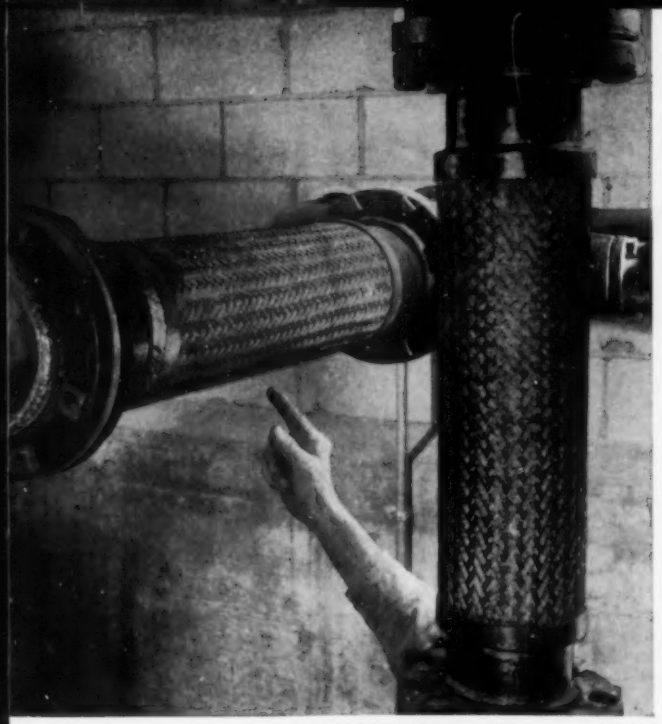
CIRCLE 118 READER SERVICE CARD

CIRCLE 119 READER SERVICE CARD→



PHOTOS PROVIDED through the courtesy of **GRAFLEX, INC.**, manufacturers of precision photographic, electronic and optical products, at the company's new multimillion-dollar Rochester, N. Y., plant.

New Flexpipe flexible bronze tubing isolates vibration, provides expansion joint for Graflex, Inc.

THE PROBLEM

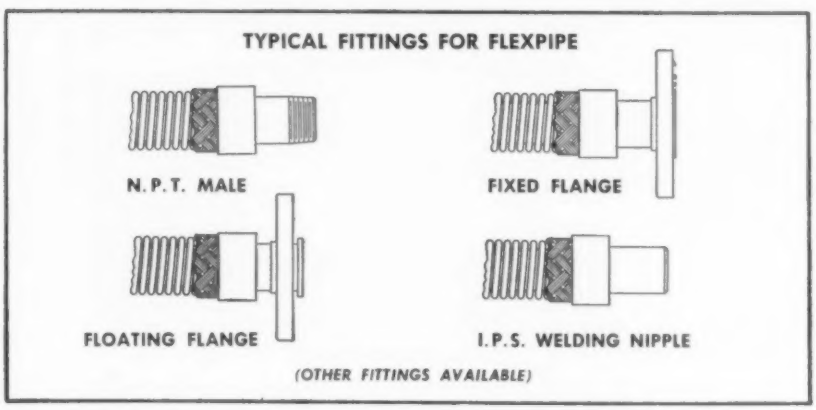
In a heating and air conditioning system, the temperature range of water and condensate varies over a 180°F. range. Some means were required to provide for expansion and contraction in the system without putting undue stress on rigid pipe and to confine the vibration to the compressors.

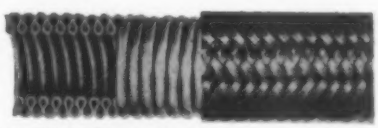
THE SOLUTION

Use of new large-size (4", 5" and 6" I.D.) American Flexpipe — flexible bronze tubing assemblies complete with end fittings.

Flexpipe connectors — in standard sizes — can solve tough problems for you, too, wherever air, gas, oil, steam or water must be conveyed, because Flexpipe:

- Has extreme flexibility that lessens chances of breakage and leakage from expansion and contraction.
- Needs little maintenance attention.
- Dampens noise, absorbs vibration, takes up movement, solves misalignment problems.
- Cuts installation costs (does away with time and material costs of rigid conduit requiring elbows, couplings, short runs of pipe, etc.).
- Makes installations quick and easy —especially in cramped quarters.





CONSTRUCTION: Inner hose corrugated for flexibility; wire braid over inner hose for added strength. Available in bronze, steel and stainless steel.

WHERE TO BUY:

Leading wholesaler distributors can provide you with information about Flexpipe in large sizes. These same distributors can show you samples and answer your questions about service applications for Flexpipe connectors in convenient standard sizes from ¾" up to 16" I.D. For the name and address of the distributor serving your area, or for more detailed information, write to: The American Brass Company, American Metal Hose Division, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

58167

Flexpipe®

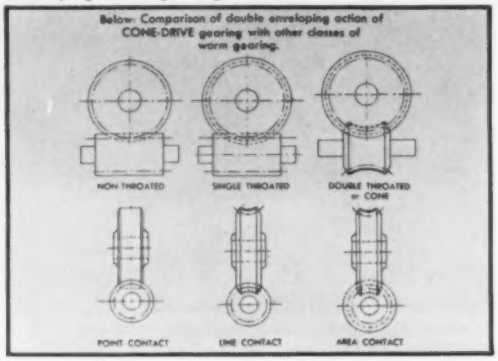
AN

ANACONDA®

PRODUCT

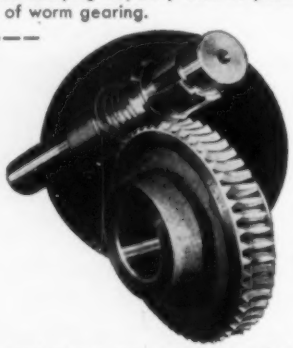
How to get the most out of Worm Gearing

If a right-angle drive is needed in your product and you require maximum capacity for your dollar, then the Cone-Drive double-enveloping type will give it to you. The sketch below shows the apparent advantages of Cone-Drive gearing as compared to other worm gear types. Double-enveloping worm gearing, the most modern and efficient

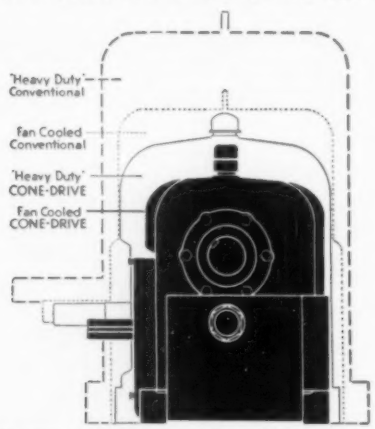

Below: Comparison of double enveloping action of CONE-DRIVE gearing with other classes of worm gearing.
NON THROATED
SINGLE THROATED
DOUBLE THROATED or CONE
POINT CONTACT
LINE CONTACT
AREA CONTACT

form, has straight-sided teeth in both worm and gear. Both elements of Cone-Drive are throated and envelop each other, providing a multiple tooth area contact. This means greater load-carrying capacity than is possible with any other type of worm gearing.

Speed reducers and gearmotors with Cone-Drive double-enveloping worm gearing are unusually compact and powerful drives that handle shock loads with ease. Yet, they provide power transmission smoother than that of hydraulic systems. Another advantage, unique to double-enveloping worm gearing, is their ability to regenerate themselves when wear occurs. Both worm and gear tend to reproduce the correct form in the other when wear occurs.



Double-enveloping worm gearing is available from Cone-Drive Gears in complete lines of gearsets, speed reducers and gearmotors. Gearsets are stocked in center distances from 2" thru 24", capable of handling loads from fractional to over 1600 horsepower. A complete line of mountings for gearsets is also stocked.



Double-enveloping worm gearing with its "wrap-around design" requires shorter center distances than cylindrical worm gearing to handle the same loads. As a result, Cone-Drive speed reducers have smaller housings with corresponding savings in weight and space. Bulky gear trains can often be replaced with a single Cone-Drive speed reducer or gearset.

DOUBLE-ENVELOPING WORM GEARSETS

DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS

DOUBLE REDUCTION WORM GEAR SPEED REDUCERS

DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

TEAR OUT AND MAIL IN FOR COMPLETE DATA

CONE-DRIVE GEARS
DIVISION MICHIGAN TOOL COMPANY
7171 E. McNichols Road • Detroit 12, Michigan
Telephone: TWinbrook 1-3111

Please send me information on following:

☐ Gearsets ☐ Gearmotors ☐ Speed Reducers

Name_____

Title_____

Company_____

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City_____ State_____

TEAR OUT AND MAIL IN FOR COMPLETE DATA

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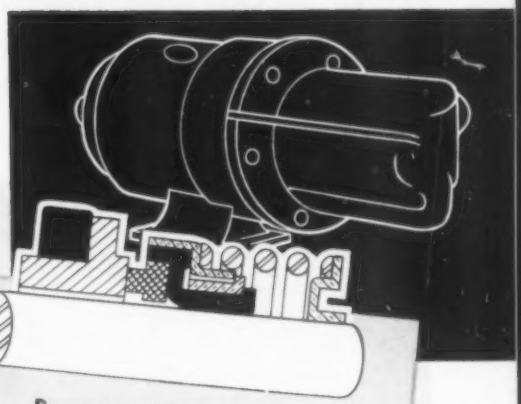
Machine Tools And Power Transmission Equipment

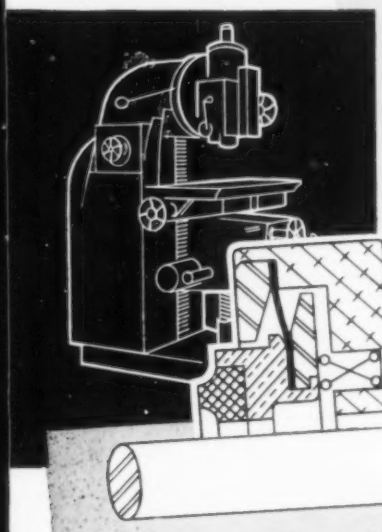
STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Stock sizes for shafts .250 through 4.000.



Pumps And Compressors

ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Stock sizes for shafts .250 through 4.000.

STYLE RFO — A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



Heavy Machine Tools

STYLE DPC — A high-speed, carbon-faced seal, for more compact installation in heavy industrial machinery. Stock sizes for shafts .250 through 4.000.

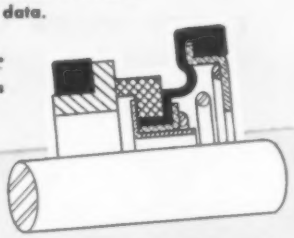
A Complete Line
GITS SHAFT SEALS
For Every Application

These modern, mechanical, face-type seals are carried in stock — to save you time and money. Write for detailed data.

GITS BROS. MFG. CO.

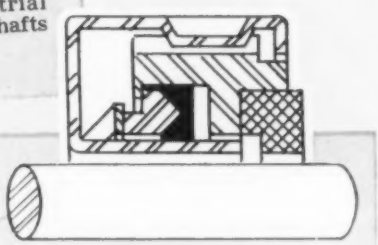
1838-A South Kilbourn Avenue • Chicago 23, Illinois

Specialists In Lubricating Devices And Shaft Seals For Almost Half-A-Century



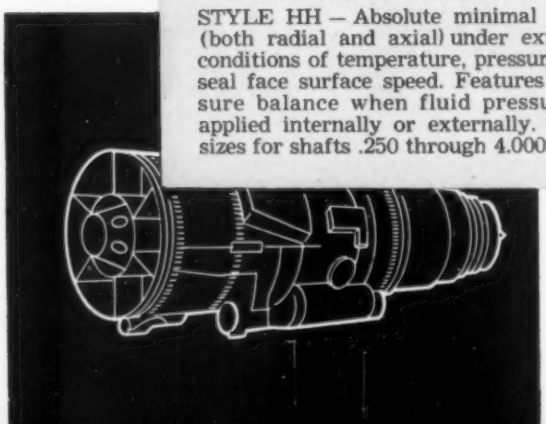
Household Appliances

STYLE SGU—A factory-assembled unit-type seal for the small-budget user. Stock sizes for shafts .250 through 1.000.



Aircraft Engines And Accessories

STYLE HH — Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Stock sizes for shafts .250 through 4.000.



New program timer features complete adjustability

In many applications, a timer has a "standard" job to do throughout its expected life, never requiring a change of timing sequence. But in many others, it's desirable to be able to change the timing sequence and the intervals making up the sequence in a complete cycle.

The new Cramer Type 511 and Type 521 Cycling Timers fill the bill for a unit combining high accuracy with complete field adjustability of as many as eight individual timed intervals. Although these timers can be supplied with preset cams to fit the needs of a present application, the added feature of adjustability makes them the ideal choice where the timing sequence may later be changed.

Operation

Applying power through an external sustained contact starts the timer, which continues to cycle until the control contact is broken. Full cycle time is the total time range of the timer specified, and may be selected from a large number of available ranges. If desired, the timer can be wired to perform one cycle and stop.

At the start of each cycle, the snap-acting SPDT load switches are in the initial positions specified (or established through adjustment) by the user. As the cycle progresses, each load switch is transferred by its operating cam to open or close its connected circuit at the required time and for the required duration.

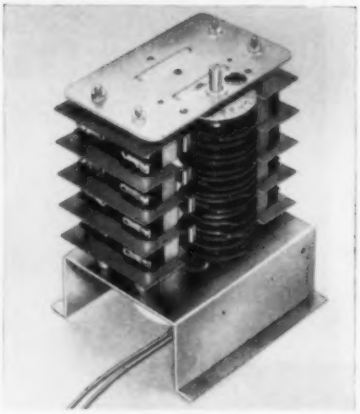
Timing Cam Adjustment

Each SPDT switch is operated by a double cam, one section to close the switch to one contact, the other to close it to the opposite contact. Depending on circuit wiring, either of these actions can "make" or "break" the load circuit. Each section of each cam is independently adjustable through a full 180°, without disturbing any other cam setting, by means of a small spanner wrench furnished with the unit. Adjustment is indicated on a dial which is marked in percent of total cycle time, permitting accurate selection of the desired "make" and "break" points for each load switch.

Features

TIME RANGES — From 1 cycle in 6 seconds to 1 cycle in 48 hours.

LOAD CIRCUITS — From 1 to 3 (Type 511) or from 4 to 8 (Type 521), each controlled by a totally-enclosed quick-make quick-break SPDT switch rated for 20 amperes at 125 or 250 volts AC (non-inductive).



Field-Adjustable Program Timer Type 521

OPERATING TIME — Minimum operating time for each circuit is approximately 1/30 of total cycle time.

ACCURACY — At operating point of any one circuit, 1½°; between any two circuits, 3°.

MOTOR — Cramer high-torque synchronous, for 115 and 230 volts, 25, 50 and 60 cycles. Motors for operation on DC or at other frequencies are available in limited time ranges.

For detailed information and complete specifications, write Cramer Controls Corporation, Box 7, Centerbrook, Conn.

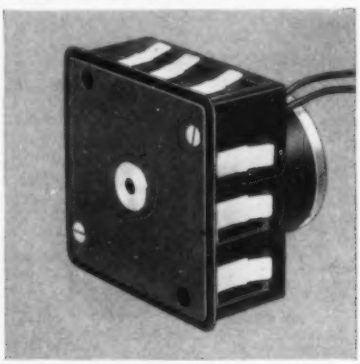
THREE MORE WAYS TO SOLVE YOUR TIMING PROBLEMS

VARIABLE-CYCLE PULSE TIMER TYPE 650

Makes or breaks an electrical circuit for a fixed period or "pulse" of ½ second to 12½ hours, at continuously repeated intervals that are adjustable from ¾ second to 24 hours. By choice of load connection, control can be based either on the fixed pulse time or on the adjustable interval between pulses. Cycling period can easily be changed during operation.

ADJUSTABLE PERCENTAGE TIMER TYPE 610

Makes or breaks an electrical circuit for a variable percentage of a basic fixed cycle time. Desired percentage of total cycle time, for ON or OFF control of the timed device, is adjustable from 4% to 96% in steps of 1%. Total cycle-time ranges from 15 seconds to 24 hours. Internal connections can easily be arranged so that the load circuit is either closed or open for the indicated percentage of the full cycle.



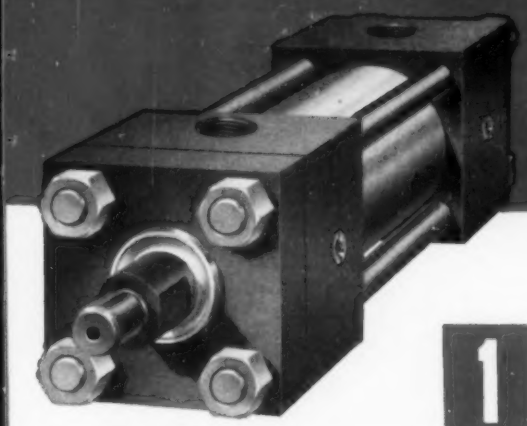
CYCLING TIMER TYPE 571

Provides reliable and inexpensive control of repetitive switching for built-in applications. One through four poles, SPST or SPDT open-blade switches with contacts rated at 30 amperes, each controlled by a timing cam specially cut to user's requirements. 18 standard speeds from 1 rpm to ⅛ rpd, plus many special time ranges.

CRAMER CONTROLS
CORPORATION
Box 7, Centerbrook, Connecticut

SEAL FAILURE MEANS CYLINDER FAILURE

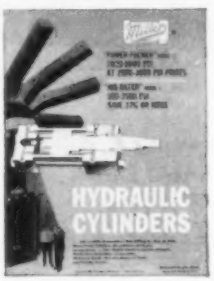
Petroleum base, fire-resistant and special hydraulic fluids cause distortion and rapid deterioration of the seals currently used in many hydraulic cylinders, resulting in costly repairs and cylinder failure. (Seals made of synthetic rubber are not compatible with even 50% of available commercial petroleum base fluids and the life of such seals is materially reduced at operating temperatures above 150° F.)



Specify Miller HYDRAULIC CYLINDERS

FOR UNLIMITED SEAL LIFE!

Request Bulletin JH-104N for complete data plus helpful charts on column strength, cylinder forces, factors of safety, acceleration, pipe pressure losses, etc.



1 ALL TEFLON* SEALED Against External Leakage

TEFLON is impervious to all known hydraulic fluids, including all fire-resistant and special types – and withstands temperatures from −100°F. to plus 450°F.

TEFLON SHEF SEAL AT TUBING ENDS

No blind assembly. Is
Shear-proof
Heat-proof
Extrusion-proof
Fluid-proof

TEFLON SEALS ON PISTON ROD AND BUSHING

Teflon rod flange seal requires no adjustment. Teflon bushing seal is shearproof. Teflon wiper keeps dirt out.

TEFLON SEALS ON BALL CHECK AND ADJUSTING SCREW

Non-protruding, self-locking, cushion adjusting screw interchangeable with ball check for easy access.

2 CASE-HARDENED CHROME PLATED PISTON RODS

Provide foolproof protection against seal failures resulting from rod damage. The Miller case-hardened rods (50-54 Rockwell C) give practically complete immunity to damage from hammer blows, wrench-dropping, mishandling, etc. The hard chrome plating over the case-hardened rods protects against scratch-damage and rust.

AVAILABLE IN TWO TOP QUALITY LINES

JOB-RATED
Model "J"

PRICE SAVINGS OF 27% OR MORE!

19 mounting styles, all strokes, cushioned and non-cushioned. Large selection for immediate shipment.

BORE	SEVERE OPERATING CONDITIONS	MODERATE OPERATING CONDITIONS	YOU SAVE THIS % IN PRICE OVER STANDARD 2000-3000 PSI CYLINDERS
1½"	1500 PSI	2500 PSI	27%
2	1500	2500	27%
2½	1000	1500	28%
3¼	1500	2500	32%
4	1000	1500	35%
5	800	1200	37%
6	800	1200	43%
8	500	800	50%
10	500	800	71%
12	500	800	76%
14	500	800	*Not Available in 2000-3000 PSI*

POWER-PACKED
Model "H"

50% More Power Per Cylinder Dollar!

For

3,000-5,000 P.S.I.

1½" through 12" bores, 17 mounting styles, strokes up to 22 ft., cushioned and non-cushioned. Large selection for immediate delivery.

*DuPont trademark for its tetrafluoroethyline resin

S SHEAR PROOF
H HEAT PROOF
E EXTRUSION PROOF
F FLUID PROOF
SEAL

Teflon Pressure Energized

Hydraulic Cylinder Tubing End Seal
PAT. APPLIED FOR

OTHER MILLER QUALITY FEATURES

- Solid Steel Heads, Caps and Mountings.
- Precision-Honed Barrels.
- Rust-Resistant Coating on All Non-Wearing Surfaces.
- Space-Saving "Square" Design.

MILLER FLUID POWER
DIVISION OF FLICK-REEDY CORPORATION

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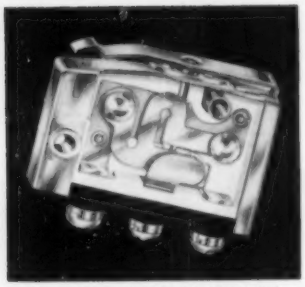
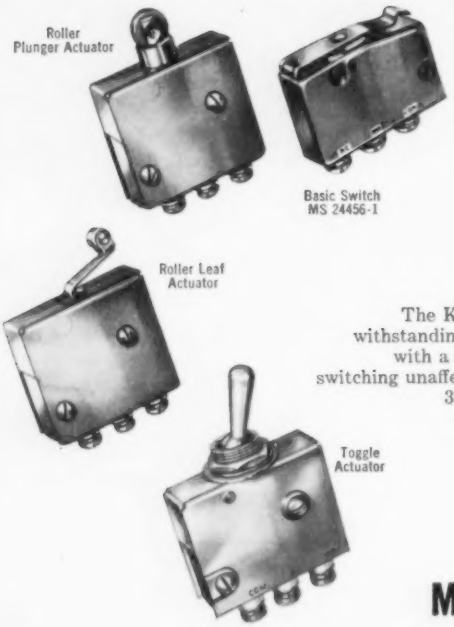
COUNTERBALANCE CYLINDERS • BOOSTERS



Cross Section of KX4 Switch (actual size)

KLIXON KX4 Hermetic Switch helps reduce weight, save power for SNARK

Cole Electric Substation



A vital weapon in the U. S. Air Force arsenal is the Northrop SNARK, a 5,000-mile Intercontinental Guided Missile. And, in the SNARK as in other operational aircraft and guided missiles, Klixon controls play a vital role.

The switch-over problem from ground to missile power was solved by a Cole Electric Company miniaturized, electrical substation which reduces the weight from several hundred pounds to 28 pounds.

And, an important component in the Cole substation is the Klixon KX4 Hermetic Switch, manufactured to exacting tolerances, **and fully approved under MS 24456-1 (USAF).**

The KLIXON KX4 Hermetic Switch is enclosed in a strong steel case capable of withstanding heavy impact and compression loads. True hermetic sealing is achieved with a metal "wave type" diaphragm at the actuating lever, providing precision switching unaffected by all environmental conditions. The KLIXON KX4 has a 10 ampere 30V D.C. or 115V A.C. rating and is available with a variety of actuators.

We'll be pleased to design special packaging to meet the requirements of your application. Write for our precision switch catalog.

Western manufacturers — refer inquiries direct to Metals & Controls Corporation, Southern California Office . . . 232 North Lake Avenue, Pasadena, California. Telephone Ryan 1-4288.

METALS & CONTROLS CORPORATION

Spencer Division 3807 Forest Street, Attleboro, Mass.

KLIXON®

Get Lower Costs — Better Performance with

GENERAL PLATE

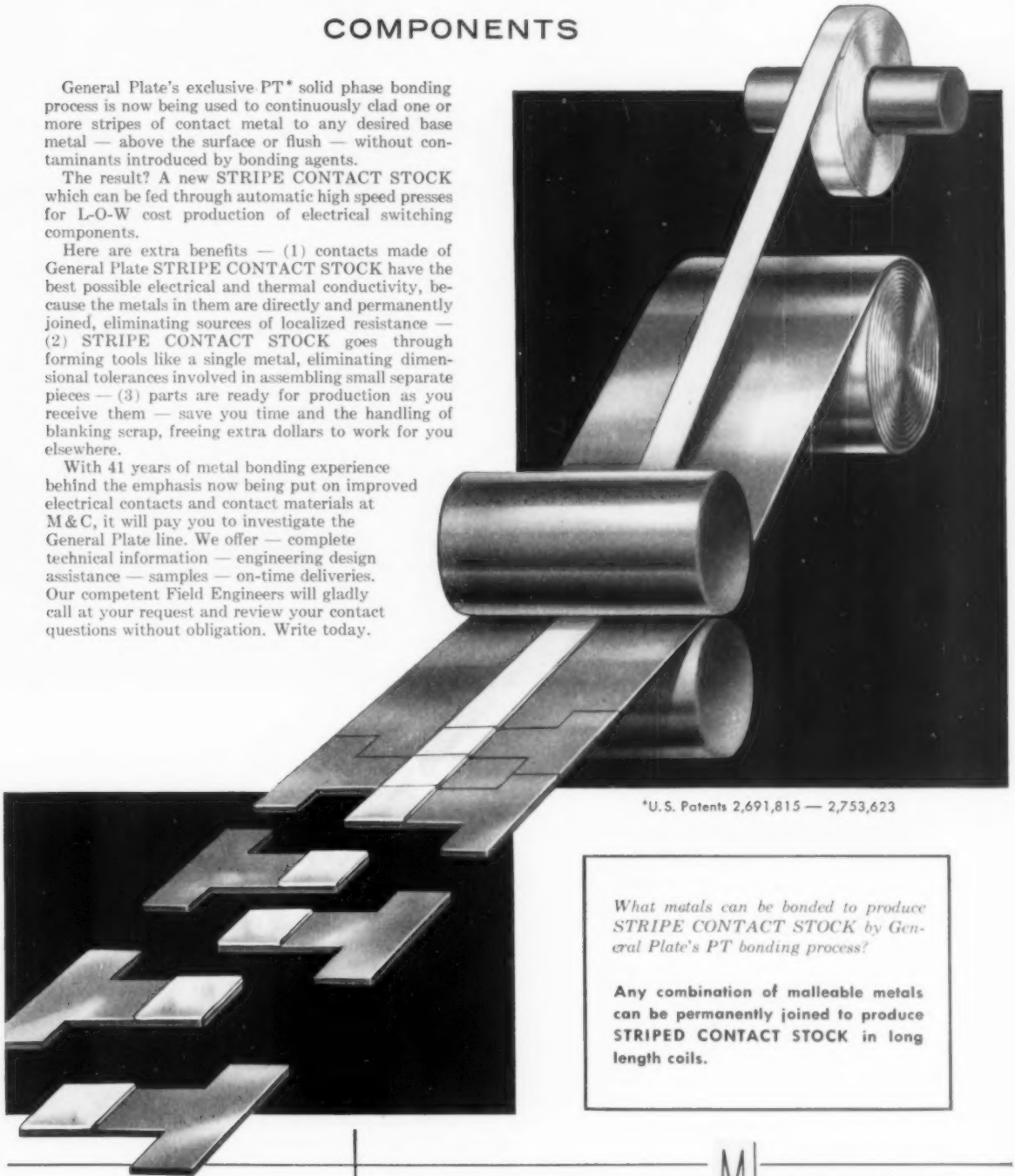
STRIPED CONTACT SWITCHING COMPONENTS

General Plate's exclusive PT* solid phase bonding process is now being used to continuously clad one or more stripes of contact metal to any desired base metal — above the surface or flush — without contaminants introduced by bonding agents.

The result? A new STRIPE CONTACT STOCK which can be fed through automatic high speed presses for L-O-W cost production of electrical switching components.

Here are extra benefits — (1) contacts made of General Plate STRIPE CONTACT STOCK have the best possible electrical and thermal conductivity, because the metals in them are directly and permanently joined, eliminating sources of localized resistance — (2) STRIPE CONTACT STOCK goes through forming tools like a single metal, eliminating dimensional tolerances involved in assembling small separate pieces — (3) parts are ready for production as you receive them — save you time and the handling of blanking scrap, freeing extra dollars to work for you elsewhere.

With 41 years of metal bonding experience behind the emphasis now being put on improved electrical contacts and contact materials at M&C, it will pay you to investigate the General Plate line. We offer — complete technical information — engineering design assistance — samples — on-time deliveries. Our competent Field Engineers will gladly call at your request and review your contact questions without obligation. Write today.



*U.S. Patents 2,691,815 — 2,753,623

What metals can be bonded to produce STRIPE CONTACT STOCK by General Plate's PT bonding process?

Any combination of malleable metals can be permanently joined to produce STRIPED CONTACT STOCK in long length coils.

You Can Profit By Using General Plate Clad Metals.

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General Plate Division

1007 Forest Street, Attleboro, Mass.

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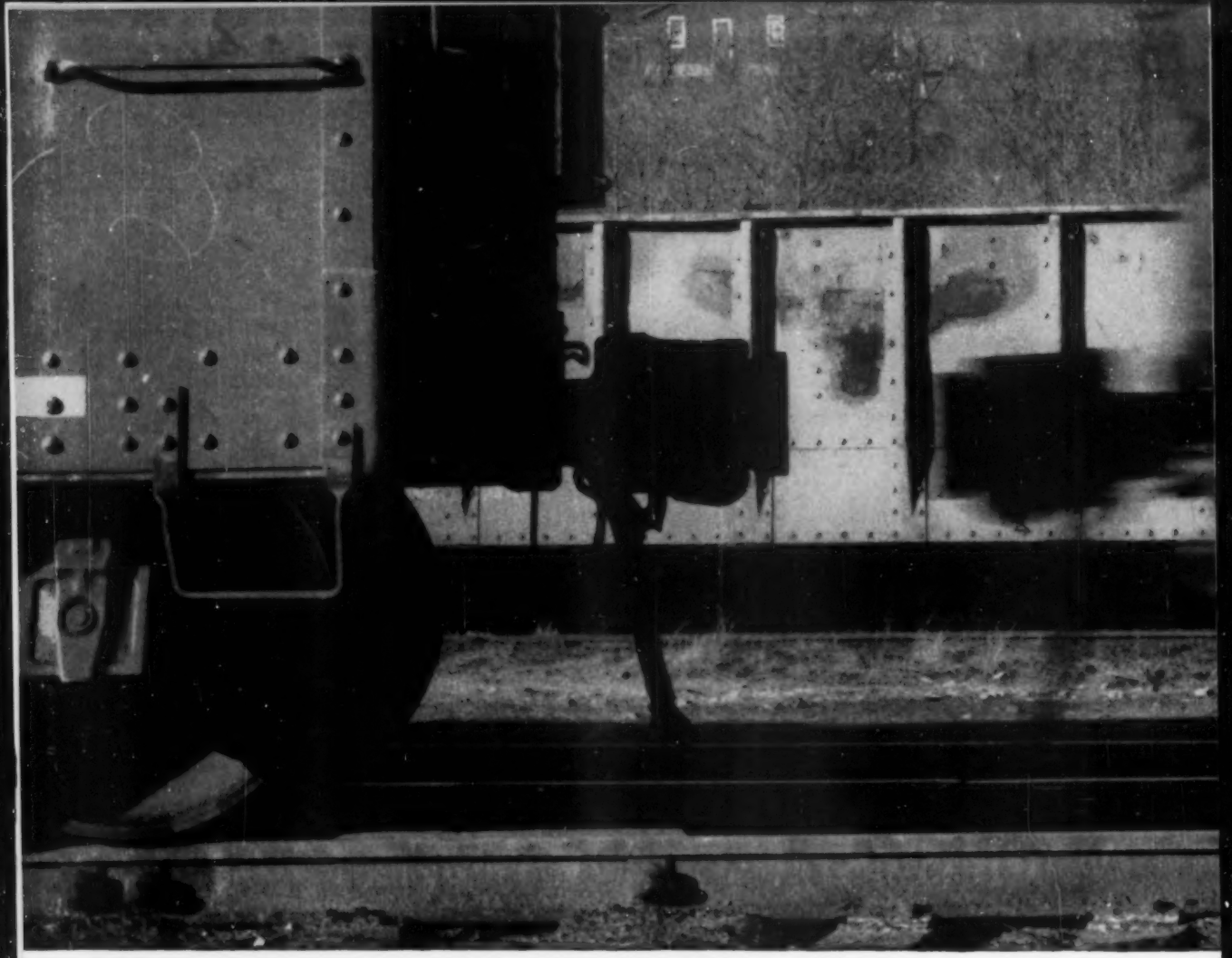


Impact resistance—The image of impact can take many forms. To a train-conscious youngster, impact might be the crash-coupling of freight cars. To the contour miner, impact is a mammoth dipper smashing into frozen highwall. To the ordnance man, impact is a shell striking armor plate. Whatever the image, impact implies one thing—toughness.

Toughness is the ability to absorb energy—to "give" under a shock load without fracturing. This property—toughness—in steel, more than in any other material, has been vital to the building of the modern world. Steel's ubiquitous role, however, belies the complexity of toughness. Because just as there are many kinds of steel, so there are many degrees of toughness, and a given steel's toughness is shaped by the admixture of its composition, manufacture and fabrication.

The design engineer, if he is to do his job well, must know his toughness in order to select the right steel for the job. He must know something of how toughness is achieved, because this often can result in using less expensive steels. The geometry of a part or structure is also important to its toughness, and here the designer reigns supreme.

In steelmaking, toughness and strength are determined by composition and manufacturing steps. Often, as is the case with USS* "T-1" Constructional Alloy Steel, a very high level of strength and toughness is obtained through selection of alloying elements and by proper heat treatment. The steelmaker can help you obtain the best combination of strength and toughness along with other desirable properties like weldability, corrosion resistance, formability and wear resistance. He can also recommend post-fabrication heat-treating practice where it is required to develop mechanical properties or relieve stress in fabricated assemblies.

Clearly, toughness is complex. But for any application, there is one best steel no matter what combination of properties you need. You are almost certain to find that steel among the great family of USS Design Steels: Carbon, High Strength, Alloy and Stainless. Our experience is yours for the asking. Write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa. You'll find our nearest representative in the Yellow Pages listed under United States Steel.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS *TRADEMARK

United States Steel

STEELS FOR DESIGN

Lower Left—Problem: Design dump cars for tunnel excavations to remove rock. Must have high impact resistance, plus corrosion resistance to withstand alternate wetting and drying. Solution: Build cars from USS COR-TEN* High Strength Steel. Pay-off: Cars take minimum maintenance, have been in continual service for six years, and are still in excellent condition.

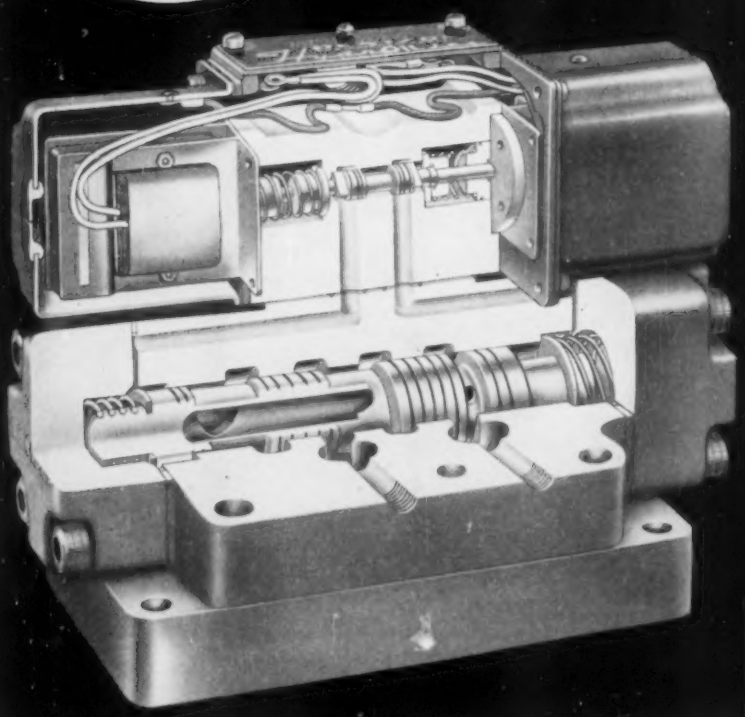
Lower Middle—Problem: Design a 60 cu. yd. shovel that could take the terrific abuse of all-weather overburden removal. Solution: Bucket, bail, dipper stick and crowd rack built entirely of welded USS "T-1"* Steel, a constructional alloy steel having exceptional toughness at below zero temperature and which can be field-welded and flame-cut. Pay-off: Outstanding performance in 7-day-a-week, 24-hour-a-day service with minimum maintenance.

Lower Right— Problem: Design a tank to hold the liquid equivalent of 10 million cubic feet of oxygen at 300°F. below zero. Solution: Tank was designed with impact-resistant austenitic USS Stainless Steel. Pay-off: Tank can withstand sudden changes of pressure, temperature changes and volume at low temperatures that would shatter other materials.

NEW from DENISON

4-WAY VALVES

Pilot-operated, solenoid-controlled for hydraulic systems up to 5000 psi



- SHORTER OVER-ALL LENGTH than any comparable valve
- SHORTEST SOLENOID POWER STROKE increases operating force
- DRAWN STEEL SOLENOID COVERS secured to body with *internal retaining* cords. No bulky, dirt-collecting chains
- BUILT-IN CHECK VALVE provides pilot pressure without adding another valve to the system
- LARGE CAPACITY PORTING for low pressure drop
- GENEROUS WIRING SPACE with ½" conduit connections on each side
- TEST CONNECTIONS for checking valve operation
- HEAVY DUTY SOLENOIDS optional D.C. operation oil-immersed solenoids available
- BUILT TO JIC STANDARDS

SHOCKLESS HYDRAULIC CONTROL for any directional control requirement is assured with Denison's new line of 4-Way Valves.

Here are *more reasons why* the exceptional design versatility of these new 4-Way Valves is important to Hydraulic Engineers –

1. Provide fast, rapid-cycle directional control of hydraulic flows up to 30 gpm.
2. Operating pressures range up to 5000 psi for both ¼" and ¾" valve sizes.
3. Operate in any porting and positioning combination.
4. Solenoid-operated ¼" valve capacity – 5 gpm.
5. Pilot-operated, solenoid-controlled ¾" valve capacity – 30 gpm.
6. Choice of spool types and spool positioning provides unlimited combinations for a wide range of applications.
7. Adjustable pilot chokes available for smooth spool reversal.
8. Interchangeable parts simplify service and model changes in the field.
9. Easily modified for operation on internal or external pilot pressure by rotating solenoid valve 180°.

DESIGNERS ENGINEERS!

Send for Bulletins VD-7, VD-8 and 240-B

for full details write

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Specify McLouth high quality sheet and strip Stainless Steel. McLouth Steel Corporation, Detroit 17, Michigan.

McLOUTH STAINLESS STEEL

NATIONAL OIL SEAL LOGBOOK

Ask yourself these questions when specifying oil seals

SHAFT RPM, FPM, RUNOUT, ENDPLAY	Is seal rated at or above my anticipated operating extremes? ☐ YES ☐ NO
TEMPERATURE, LUBRICANT TYPES	Will heat or special-purpose lubricants attack my sealing lip compounds? ☐ YES ☐ NO
PRESENCE OF DIRT OR OTHER FOREIGN MATERIAL	Point often overlooked. If present, should I specify dual-lip sealing member? ☐ YES ☐ NO
COST RELATED TO SEAL DESIGN	Will a simpler, less expensive seal do as good a job as a more sophisticated unit? ☐ YES ☐ NO
NEW SEAL DESIGNS AND MATERIALS ON MARKET	Are there new high temperature, high speed compounds I should examine before specifying? ☐ YES ☐ NO
SPECIAL DESIGNS FOR SPECIAL PROBLEMS	Not all sealing jobs can be met with stock seals. Do I need a special factory design? ☐ YES ☐ NO
DELIVERY, REPUTATION FOR QUALITY	Is my resource noted for on-time delivery, uniform quality, and good follow-up service? ☐ YES ☐ NO

Don't specify "blind." Your National Oil Seal Engineer has up-to-date data on seals—old, new and under development. He understands current sealing parameters; what special designs can probably be developed. His frank, free counsel can't help but lead to better sealing, faster assembly, simpler servicing, faster delivery or lower cost.

Call him today. Number's in the Yellow Pages, under Oil Seals.

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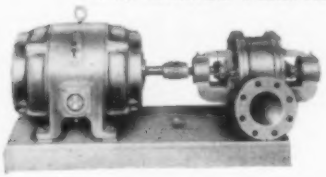
BUILT-IN ASSURANCE

To Help Make Your Plans Work As Specified...

F-M WESTCO PERIPHERAL PUMPS



boiler feed
condensate return
hot and cold liquids
chemicals
refrigerants, etc.

Up to 200 gpm., pressures to 900 ft. High pressure at normal operating speeds. Handle widely varying heads with little change in capacity. Sizes 1¼" through 2½".

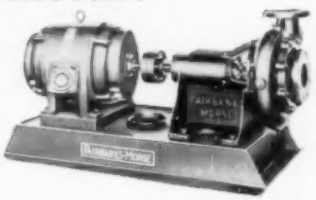
F-M BUILTOGETHER CENTRIFUGAL PUMPS

hot and cold liquids
liquid circulation
low-viscosity liquids
boiler feed
cooling towers, etc.

Up to 900 gpm., pressures to 525 ft. Close-coupled pump and motor units mount horizontal, vertical or angular. Sizes ¾" through 5".

F-M NON-CLOG PUMPS

plant waste
slurries
paper stock
fruit
fish
vegetables, etc.



Up to 30,000 gpm., pressures to 175 ft. Sizes 2" through 20". Vertical or horizontal. Bladeless or conventional.

The best-laid plans can go astray when mechanical equipment fails to deliver according to expectations or fails to give sustained peak performance. That's why Fairbanks-Morse builds something extra into all pumps so your plans work *as specified.*

F-M Pumps You Can Rely Upon

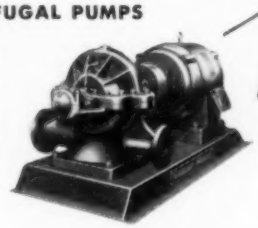
Full-rated capacity guaranteed...with built-in safety margin to assure maximum efficiency under most severe use. Rugged, durable, precision-made to maintain efficiency with minimum service.

Expert Help When You Want It

F-M Engineers are ready to work with you on any of your pump problems.

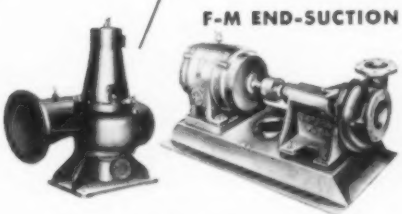
F-M SPLIT-CASE CENTRIFUGAL PUMPS

water supply; plant service
booster; circulating
air conditioning
refrigeration
chemical liquids
boiler feeds, etc.



Up to 50,000 gpm., pressures to 700 ft. Sizes 1½" through 36". Single stage or multistage.

F-M END-SUCTION PUMPS



hot and cold liquids
chemicals
circulating liquids
low-viscosity liquids
cooling towers
condensor circulation, etc.

Up to 100,000 gpm., pressures to 250 ft. Sizes ¾" through 54". Horizontal or vertical.

For full information about Fairbanks-Morse pumps, call your F-M Sales Engineer or write Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.

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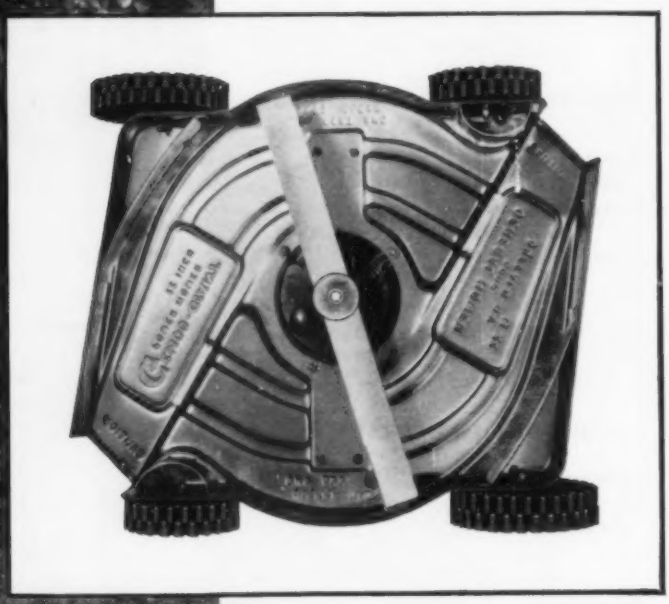
In Gemco Power Mowers,

REPUBLIC NYLOK FASTENERS SAFEGUARD PERFORMANCE SPECIFICATIONS



REPUBLIC NYLOK FASTENERS are used extensively on Gemco Rotary, Reel, and Riding Power Lawn Mowers. Insert shows blade assembly securely locked to engine shaft with Nylok Cap Screw. An added advantage of Republic Nylok Bolts and Cap Screws for some applications is their ability to seal against fluid escape when wrenched tight. Nylon pellet in bolt body blocks flow of fluid along helical thread path.

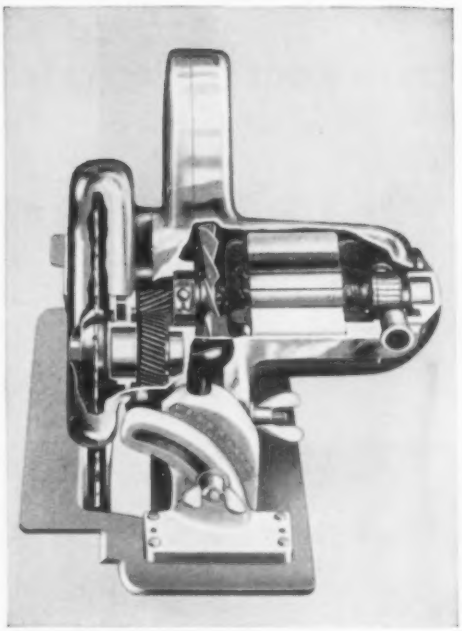
Modern Gemco Power Mowers, manufactured for General Mower Corporation, Buffalo, New York, are designed to deliver reliable, heavy-duty service with minimum of maintenance. Gemco engineers safeguard these performance specifications by using only quality materials, including Republic Nylok® Bolts and Nuts for critical assembly connections.

For example, in the Gemco Rotary Mower line, a particularly vital point is the assembly of blade to engine drive shaft. Use of a Republic Nylok Hex Head Cap Screw for this purpose assures a vibration- and shock-proof connection of maximum safety and strength. Moreover, the Nylok cap screw can be repeatedly removed and re-used to permit blade sharpening, reversal, or replacement—without loss of holding power.

The unique characteristics of Republic Nylok Bolts and Nuts suit them perfectly to many tough fastening problems. Permanent locking is provided by a nylon pellet imbedded in the fastener body which forces a tight, metal-to-metal lock between opposite mating threads. A positive grip is maintained wherever wrenching stops. Resiliency of pellet allows both adjustment and re-use.

It will pay you to explore these and other advantages of Republic Nylok Fasteners in relation to your assembly requirements. For details, contact your nearest Republic Office, or mail coupon.

ECONOMY, CORROSION-RESISTANCE, AND PAINT-HOLDING SPECIFICATIONS make Republic Electro Paintlok® Sheets ideal for this unusual product. Produced by the Self Sett Mouse Trap Company, Cleveland, Ohio, it is a fully automatic mouse trap. Mr. E. S. Coughanor, President, found Republic Electro Paintlok best by actual test for every requirement. If you want to "build a better mouse trap" in your product field, the features of Republic Electro Paintlok may work to your advantage. For details, mail coupon.



REPUBLIC COLD FINISHED ALLOY STEELS provide required reliability in gear components of this portable electric saw produced by the Black & Decker Manufacturing Company, Towson, Maryland. The strength and toughness of these steels enables Black & Decker gears to shrug off repeated shock and heavy loading—and come back for more. Republic Cold Finished Alloy Steels may provide the perfect answer to a tough application or production problem troubling you. Send coupon for further data.

MELTING POT AND FLYWHEEL SPECIFICATIONS for these castings produced by The Union Metal Manufacturing Company, Canton, Ohio, call for a pig iron with great machinability, density, and heat resistance characteristics. Over the years, the ideal answer to these requirements has been Republic Chateaugay Pig Iron. Exclusive with Republic, Chateaugay combines high carbon with unusually low phosphorus and is copper-free. Chateaugay's uniform distribution of chemical elements produces a dense grain structure which results in economical machining, plus excellent heat- and wear-resistance. For more information, mail coupon.

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if it uses WESTERN FELT!

Such efficiency is possible in a Hersey reverse-jet filter with particle size of 5 microns and a pressure drop of ½ inch of water.

Felt can be used to filter solids from solids, solids from liquids, or solids from gases. It is used effectively in fuel filters, air filters, chemical filters, respirators, or dust collectors.

Microscopic barbs on the live fibers of Felt make felt the ideal filtering medium. These scales collect and hold dust particles. They also encourage "build-up" or caking which actually increases filter efficiency. At the same time, their natural interlocking action holds fibers tightly together, through years of flexing.

For helpful engineering information on filtration felts, write

WESTERN *Felt* **WORKS**

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Chicago 23, Ill.

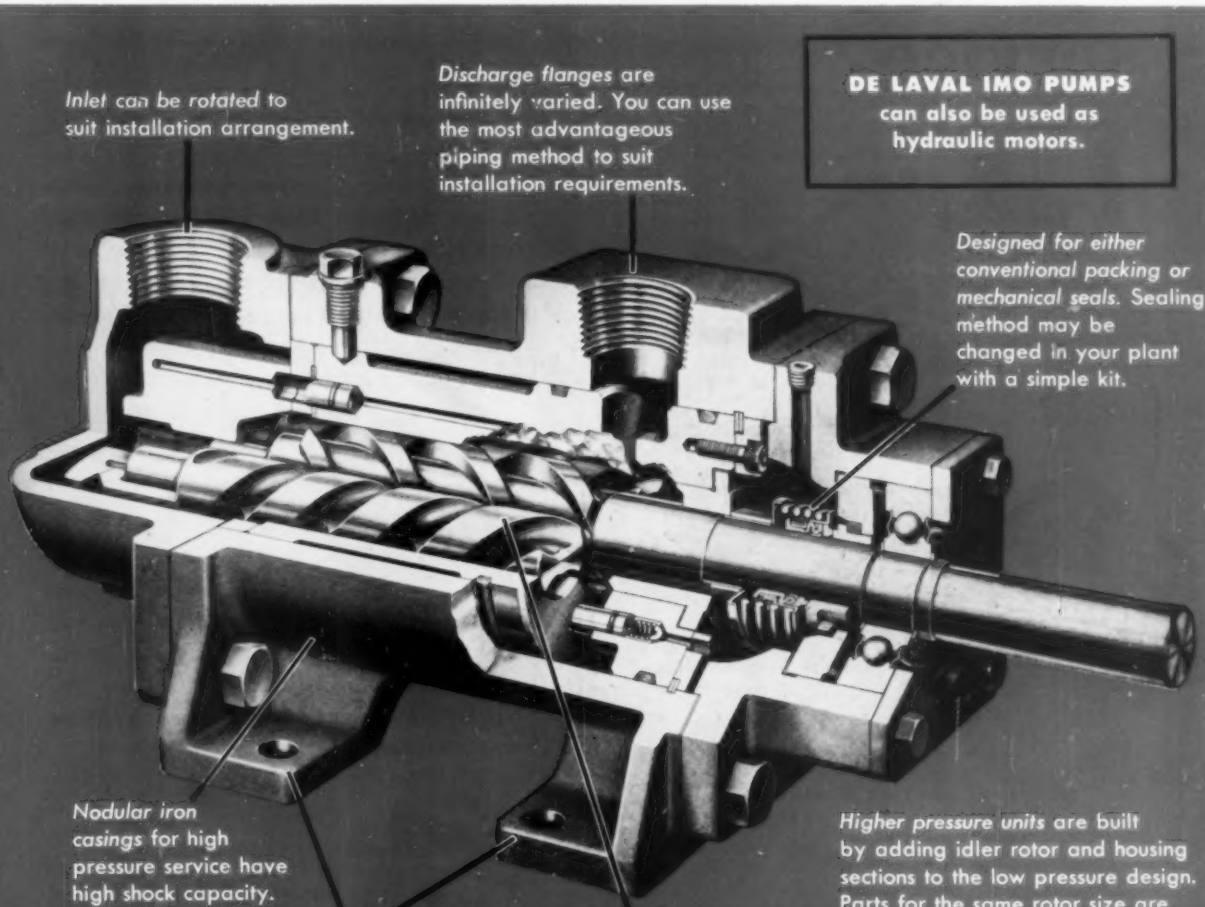
MANUFACTURERS AND CUTTERS OF WOOL FELTS

DE LAVAL
IMO PUMPS

are now more versatile than ever

De Laval IMO pumps have proved that they do a dependable job over long years of service. The reason is IMO design simplicity. These constant displacement rotary pumps have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation. There are no timing gears, cams, valves, sliding vanes, or reciprocating parts to wear or become noisy. *Quiet*, compact IMO pumps are excellent for direct-connected, high-speed operation.

In addition to these basic pumping advantages, the improved IMO gives you important new benefits shown in the cutaway illustration below.


Inlet can be rotated to suit installation arrangement.
Discharge flanges are infinitely varied. You can use the most advantageous piping method to suit installation requirements.
DE LAVAL IMO PUMPS can also be used as hydraulic motors.
Designed for either conventional packing or mechanical seals. Sealing method may be changed in your plant with a simple kit.
Nodular iron casings for high pressure service have high shock capacity.
Any position mounting is possible without factory modification.
Higher pressure units are built by adding idler rotor and housing sections to the low pressure design. Parts for the same rotor size are interchangeable over the entire pressure range.
Internal parts are designed as a package so that units can be built into your machines.

Bulletin 3001 gives data on improved De Laval IMO pumps. Send for your copy today.

DE LAVAL *IMO Pumps*

DE LAVAL STEAM TURBINE COMPANY

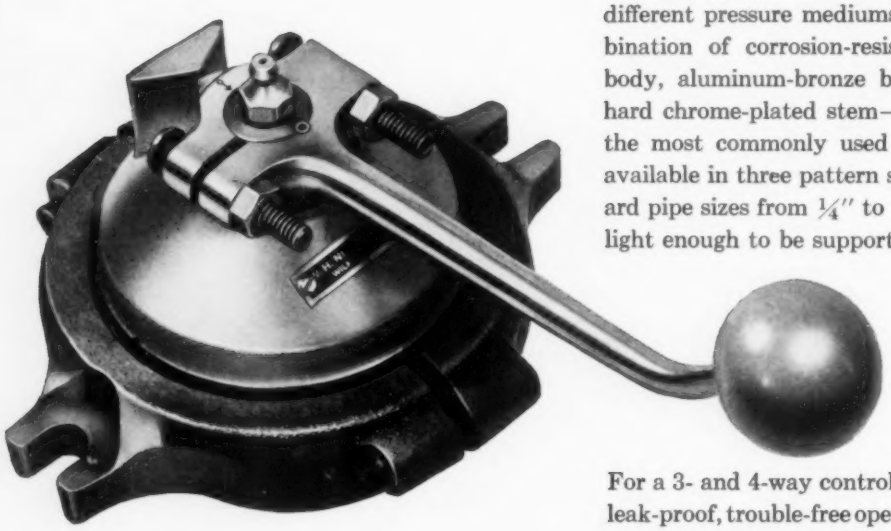
801 Nottingham Way, Trenton 2, New Jersey

DL 418

CIRCLE 133 READER SERVICE CARD

Here's a control valve that assures you

leak-proof service



Highly-lapped metal-to-metal surfaces of this Nicholson control valve assure you leak-proof service. The O-ring stem packing and O-ring seal between the body and base make joints leak-proof without excessive bolt tension.

You can use the Model 300 with air, water, hydraulic fluid or oil as the pressure medium . . . at operating pressures to 300 psi. Use it to activate single- or double-acting cylinders. Simple and rugged, this valve provides accurate, repeatable control of equipment such as presses, hoists, clutches and chucks. Valve maintenance is no problem . . . all stem, base and disc bearing surfaces are lubricated through one easily accessible fitting on top of valve stem. Lubricant reservoir in base reduces frequency of lubrication.

No need to stock valves or parts for service with different pressure mediums. This valve's *one* combination of corrosion-resistant materials—bronze body, aluminum-bronze base, stainless-steel disc, hard chrome-plated stem—is well suited for all of the most commonly used pressure mediums. It's available in three pattern sizes covering five standard pipe sizes from ¼" to 1" . . . small enough and light enough to be supported by connected piping.

For a 3- and 4-way control valve that will give you leak-proof, trouble-free operation, specify Nicholson. W. H. NICHOLSON AND COMPANY, 14 OREGON ST., WILKES-BARRE, PA. Sales and Engineering Offices in 98 principal cities.

Write for Bulletin 300 . . . covering design, construction, sizes and applications for the Model 300

NICHOLSON

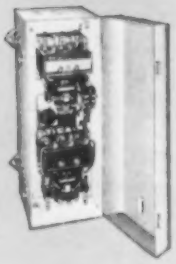
OF WILKES-BARRE

ALLEN-BRADLEY *Quality* Reduced Voltage Motor Starters

AUTOMATIC GRAPHITE RESISTOR TYPE

Graphite disc resistors are automatically inserted in series with the squirrel cage motor at starting. These resistors can be steplessly adjusted for motor and load conditions, resulting in remarkably smooth acceleration of the motor.

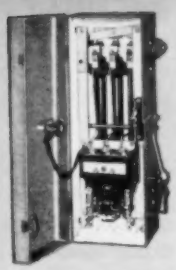
BULLETIN 740



MANUAL STEPLESS RESISTANCE TYPE

Graphite compression disc resistors provide smooth, stepless starting of polyphase squirrel cage motors—prevent lamp flicker. Operated by a hand lever, the smooth starting of the motor is under the control of the operator.

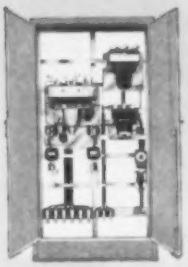
BULLETIN 640



AUTOMATIC MULTIPOINT RESISTANCE TYPE

Meets power company starting current rules on network systems. Resistors are automatically inserted in the line at starting, and are short circuited in steps at definite time intervals which can be adjusted from 1 to 5 seconds.

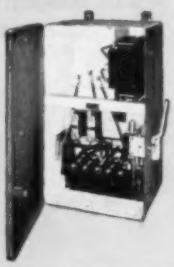
BULLETIN 741



MANUAL AUTOTRANSFORMER TYPE

Recommended where the characteristics of the driven load or power company rules require reduced voltage starting. Double break, silver alloy contacts are standard for air-break starters . . . copper contacts for oil-immersed units.

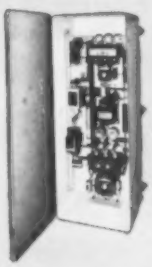
BULLETIN 646



AUTOMATIC STEPLESS GRAPHITE RESISTOR TYPE

The ultimate in velvet smooth acceleration of squirrel cage motors. Lamp flicker on network systems used for both power and light is eliminated. The graphite disc resistors are compressed automatically . . . smoothly and steplessly.

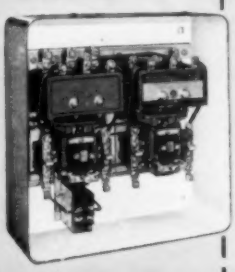
BULLETIN 742



AUTOMATIC PART-WINDING TYPE

For use with squirrel cage motors having two separate parallel stator windings. Two types—Style A, two step starter; Style B, three step starter having resistance in series with motor on the first step.

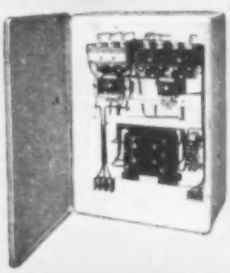
BULLETIN 736



AUTOMATIC AUTOTRANSFORMER TYPE

Utilizes an autotransformer connected in open delta to reduce line voltage for starting squirrel cage motors. Taps are provided on the autotransformer to adjust the voltage applied to the motor.

BULLETIN 746



A-B QUALITY

The Sign of QUALITY Motor Control

ALLEN-BRADLEY

MOTOR CONTROL

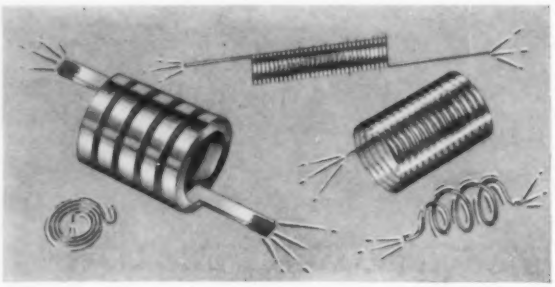
QUALITY

Allen-Bradley Co., 1315 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Design may be affected when springs must carry current.

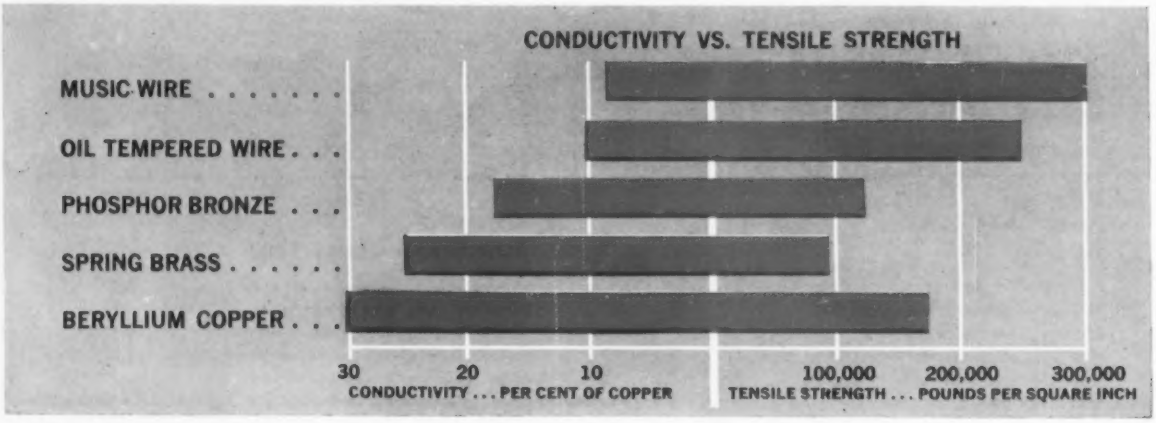
Good electrical conductivity or low electrical resistance of spring materials must be considered in relation to working stresses. When springs must carry current with a minimum of heating, the copper base alloys offer the most logical choice for the spring material. But most of these alloys are relatively low in strength, and the elastic modulus is low also. Since both the strength and modulus affect the design, conductivity and stress must be taken into consideration right at the start.

This conflict between conductivity and strength may be better understood by referring to the bar chart. Here, the bars to the right of the vertical line show the approximate relative tensile strength while the bars to the left indicate relative electrical conductivity of commonly used materials.



Requirements for good conductivity mean generous cross sections and low stresses which minimize the creep tendency of constantly stressed springs.

A.S.C. research and experience is at your service in all fields of spring usage. Write for your copy of "Spring Design and Selection — in brief."


CONDUCTIVITY VS. TENSILE STRENGTH
MUSIC WIRE . . . . . .
OIL TEMPERED WIRE . . .
PHOSPHOR BRONZE . . .
SPRING BRASS . . . . . .
BERYLLIUM COPPER . . .
30
20
10
CONDUCTIVITY . . . PER CENT OF COPPER
100,000
200,000
300,000
TENSILE STRENGTH . . . POUNDS PER SQUARE INCH

Associated Spring Corporation

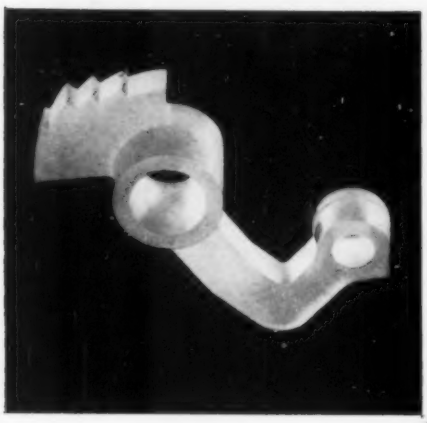
General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Seaboard Pacific Division, Gardena, Calif.
Cleveland Sales Office, Cleveland, Ohio
Raymond Manufacturing Division, Corry, Penna.
Ohio Division, Dayton, Ohio
F. N. Manross and Sons Division, Bristol, Conn.
San Francisco Sales Office, Saratoga, Calif.
William D. Gibson Division, Chicago 14, Ill.
Milwaukee Division, Milwaukee, Wis.
Dunbar Brothers Division, Bristol, Conn.
Wallace Barnes Steel Division, Bristol, Conn.
Canadian Subsidiary: The Wallace Barnes Co., Ltd., Hamilton, Ontario and Montreal, Quebec

5809

CIRCLE 137 READER SERVICE CARD →

1 Nylon replaces metal in this idling cam made by Chicago Molded for Holley Carburetor. By injection molding it of nylon, Chicago Molded eliminated 3 operations—hardening, stamping and assembly. *This cuts production costs 50%.* Chicago Molded went even further and designed a unique mold with removable sections. This represents advance planning for easy changes in the number and sizes of the ratchets at lowest expense. Picture how this kind of foresight could keep your costs down.



2 One part replaces three in this paint spray gun body developed with the help of Chicago Molded. By injection molding it from nylon as a single part, Chicago Molded eliminated several machining, polishing, buffing and plating operations previously required for metal guns. In addition to the cost-cutting advantages of this new nylon design, it is two-thirds lighter, is not affected by solvents, and makes a tighter air seal than die-cast aluminum. Do you have a similar part or component?

4 ways *Chicago Molded might cut your parts costs*

3 This new "Schlitztap" looks like expensive bone china, but it's actually made of melamine. Engineered and molded by CMPC, the plastic parts of the "Schlitztap" not only cost less than their ceramic counterparts but are almost indestructible. They're immune to perspiration, scratching, staining and chipping. This is the first time that it has been practical to duplicate decorated ceramics that have compound curved surfaces.

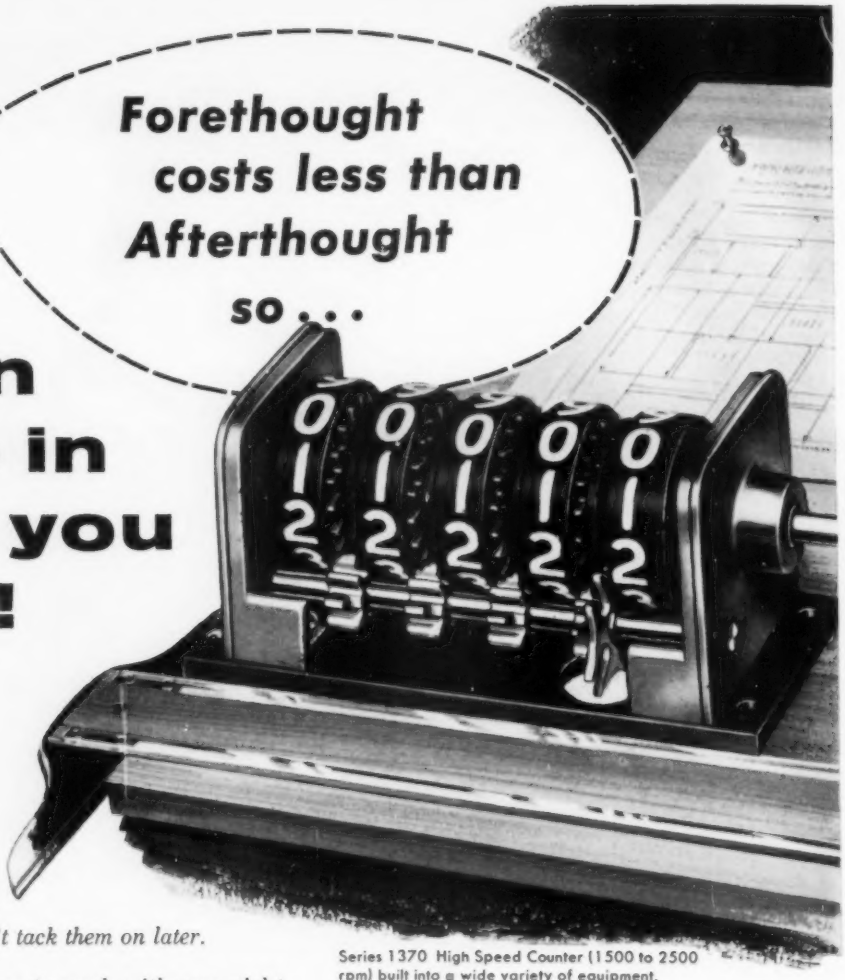
4 An injection-molded—31" x 16"—styrene cover replaces a die cast part at a lower cost in this Magna Bandsaw. Furthermore, the color's *in* the plastic, eliminating the cost of painting during manufacture. And the cover can't chip, peel, or fade. Chicago Molded's engineers can suggest ways to make good products better *and at lower cost* through the use of molded plastic parts.

LET CHICAGO MOLDED KNOW YOUR COST PROBLEMS It may be possible to solve them and make a better product too—with a slight change in design, or material, suggested by Chicago Molded. Our engineers have exceptional experience in doing just this. Your problems are their job. So let us know if we can be of help. Contact:

CHICAGO MOLDED
PRODUCTS CORPORATION
1032 North Kolmar Ave., Chicago 51, Ill.

Forethought costs less than Afterthought so . . .

Design These in When you Begin!



If you need mechanical or electrical counters in any of your new products, here's a word to the cost-wise designer: *Design them in, when you begin . . . don't tack them on later.*

Series 1370 High Speed Counter (1500 to 2500 rpm) built into a wide variety of equipment.

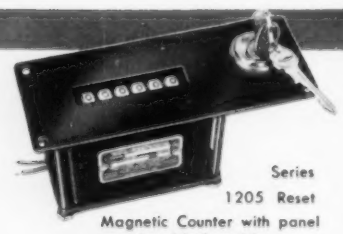
For if you'll give us a chance to work with you, right from the beginning, chances are we can save you time and money by adapting or modifying a *standard* Veeder-Root Counter to your needs . . where you might get into a costly special job if you went about it alone. What's more, you save time in your engineering, purchasing and assembly departments.

Count on Veeder-Root to help you in every way . . . from design to delivery. Write:

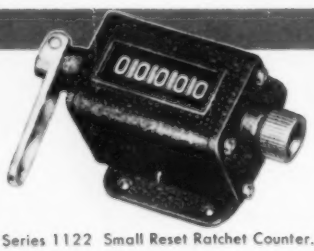
Everyone... Can Count on Veeder-Root

INCORPORATED

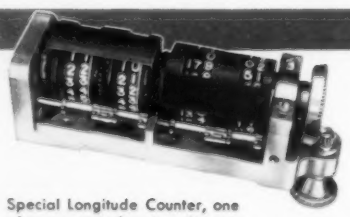
Hartford, Conn. • Greenville, S. C. • Chicago
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities



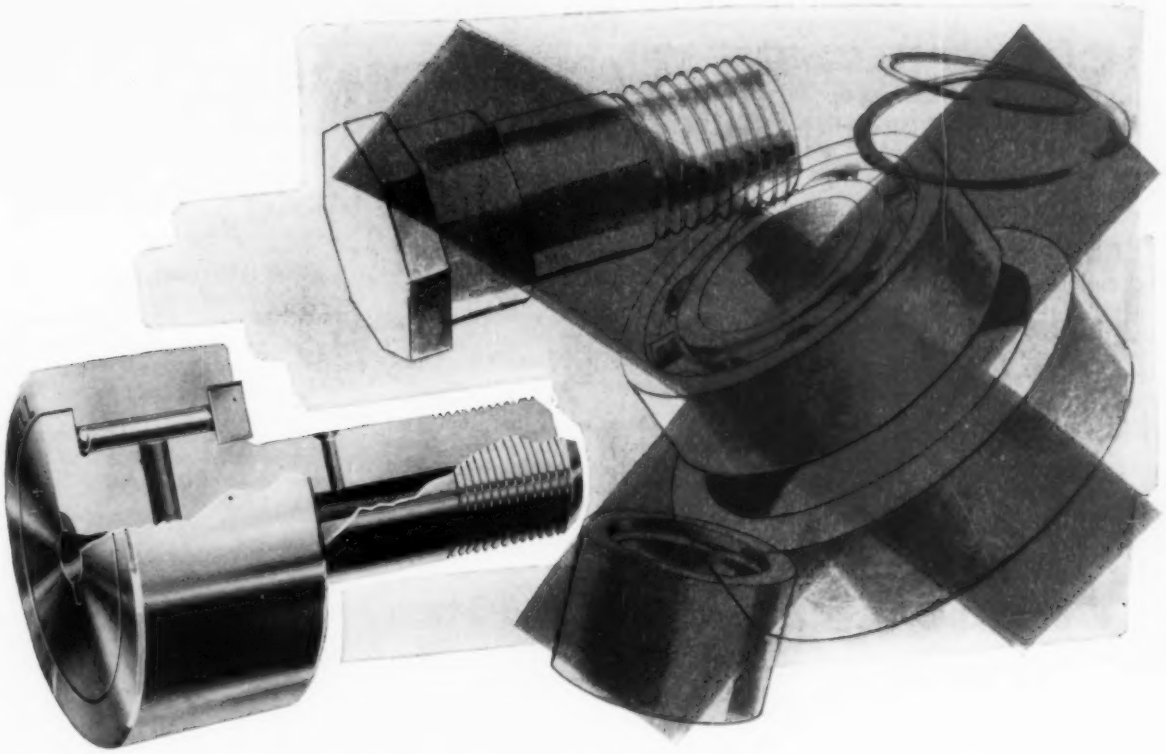
Series 1205 Reset Magnetic Counter with panel mount and lock and key.



Series 1122 Small Reset Ratchet Counter.



Special Longitude Counter, one of many made for aircraft navigational equipment.



McGILL® CF *CAMROL*® bearings

eliminate the cost of producing and assembling improvised cam follower, track and guide roller units

THESE CAMROL ADVANTAGES SOLVE COST, DESIGN, PRODUCTION AND PERFORMANCE PROBLEMS:

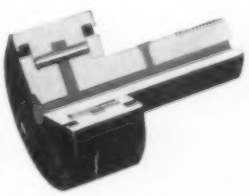
• AVAILABILITY • INTEGRAL UNIT CONSTRUCTION • HIGH LOAD CAPACITY • SMALL RADIAL SPACE REQUIREMENTS • HIGH SHOCK RESISTANCE • PRECISION ACCURACY • SIMPLIFIED LUBRICATION

You can simplify design and cut cost with CAMROL, precision cam followers. Procurement, production and assembly of components for improvised units are eliminated when you specify CAMROL bearings that are available from stock.

McGill developed the original roller bearing cam follower and perfected the CAMROL design through 25 years of application experience. Its full type construction provides exceptionally high capacity in an integral unit of a flanged, specially heat treated stud and heavy shock resistant outer race. Grease lubrication is simplified. Plain bearings require constant oil lubrication and bolt mounted ball bearings races crack under equivalent loads.

Precision construction, including concentricity of stud to outer race OD, provides accurate alignment of machine members. Ease of interchangeability and dependable operation in any cam action, track, guide or support roller application is assured. Use the CYR series in the same roller diameters for shaft mounting.

PRE-LUBRICATED SEALED CAMROL BEARINGS



These bearings combine the advantages of CF and CYR series bearings plus effective sealing against dirt, dust and grit. Ideal in applications where lubrication is a problem. Black ferrous oxide finish resists corrosion in contaminated areas.

CAMROL bearings are available in standard roller diameters from ½" to 4". Capacities to 20480 lbs. at 100 RPM.

WRITE FOR FREE CATALOG NO. 52-A

engineered electrical products

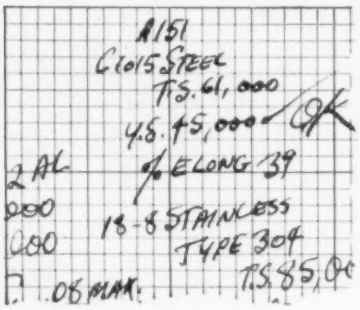
McGILL®

precision needle roller bearings

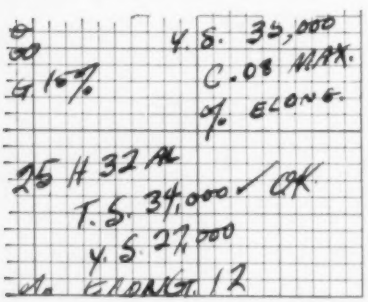
McGILL MANUFACTURING COMPANY, INC., 201 NORTH LAFAYETTE STREET, VALPARAISO, INDIANA

Plus-tensile cold formed into stamped components

Only the stamping method of production offers such an unrestricted latitude of material selection. With stampings, strength can be designed right into a product or component part. It can be specified into the basic material and improved during the stamping process . . . it can be predicted, controlled and maintained. Strength in stampings can, in fact, be higher in proportion to weight than is possible in any other metalworking process.



All parts, pieces or units are designed around their predetermined end use. The end use pretty much dictates the material to be used in making the component. Only in stampings are the metal, finish and inherent characteristics of the part completely controlled and established beforehand by the design demands. With stampings, there is no need to sacrifice strength to gain other desirable properties. And in stampings, strength is achieved and not just approximated.



Durability is another quality inherent in every stamping. Because stampings are not fragile, they will not break or crack even when thrown out of line or dented by careless handling.

The resilience which characterizes stampings adds to their versatility in production, shipping, finishing and to the manner of their final assembly with other stampings, other component parts, to form a finished product.

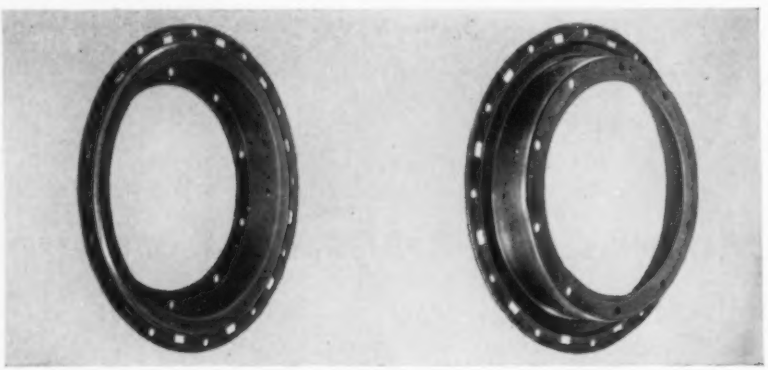
How to get permanent close tolerances without costly machining

Because the side housings of the Fawick Airflex Type E clutches are stamped to close tolerances, no costly machining is required before assembling.

This unique clutch puts all the load on torque bars which rest on the stamped housings. The clutch design takes full advantage of the inherent strength of the positioned steel.

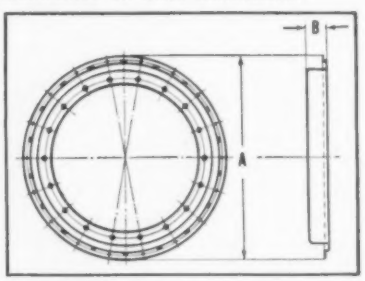
The Fawick clutch assemblies are used in a wide range of sizes for clutch and brake applications in heavy-duty original equipment.

Typical tolerances in the Fawick stamped housings are +.005" − .000", +.005" −.005", +.000" −.010". Special notes on shop drawings call for all holes equally spaced, within tolerances of plus or minus .005" while parallel surfaces are maintained. COMMERCIAL'S ability to meet such stiff stamping requirements reflects its skill and experience in handling unusual metal forming problems.



Close tolerances on pierced holes and slots insure perfect alignment of mating parts in final assembly.

Gang piercing provides the required dimensional and location accuracy of holes and slots without the cost of multiple drilling. Slotted openings with integral tabs are formed without metal fracture. The sharp bottom radii and straight sidewalls require a deep draw. Yet, close tolerances must also be maintained on these dimensions.



A	11⅞	13⅞	15⅞	18⅞	21⅜
B	2⅝	2⅝	2⅝	2⅝	2⅝
A	23⅞	26⅞	29⅞	33⅞	39⅞
B	2⅝	2⅝	3 1/32	3 1/32	3 29/32

These clutches in use on power shovels, locomotive cranes and other heavy-duty equipment, keep the load from slipping through friction. The housings stamped by COMMERCIAL withstand the load and the heat generated by the friction involved, yet maintain the alignment and accurate dimensions to which they are stamped.

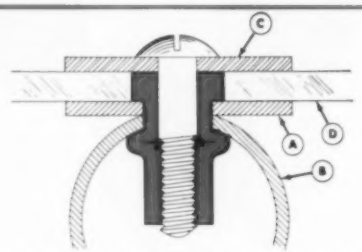
If you have a design problem involving component parts, we may be able to suggest a practical and economical solution based on our 30 years experience in forming metals. Send details of your problem to Commercial Shearing & Stamping Company, Dept. G-30 Youngstown 1, Ohio.

COMMERCIAL shearing & stamping

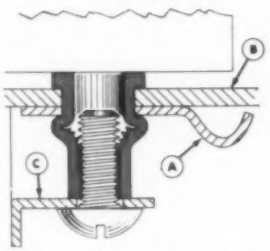
B. F. Goodrich Rivnuts®
save time, cut costs by doing...

B.F.Goodrich

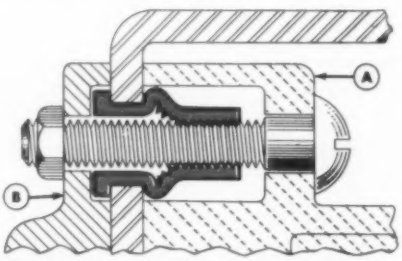
Do you have dual fastening problems like these?



In airplane window seal, Rivnut rivets plate (A) to center post (B), provides nut plate to hold clamp strip (C). Rivnut head serves as spacer for transparent plastic sheets (D). Result: a neat, weather-tight seal!

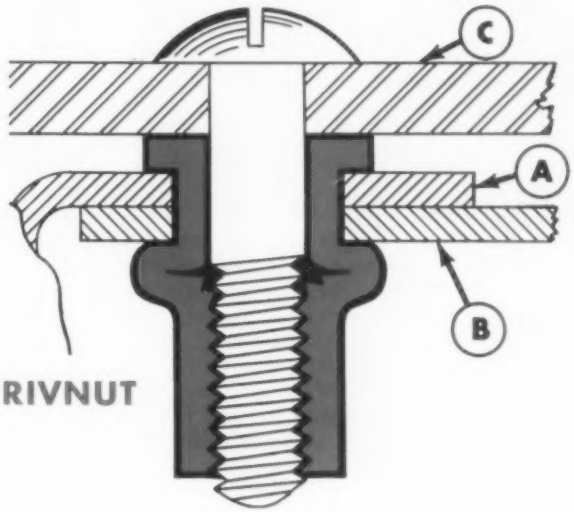


In vaporizer assembly, Rivnut rivets upper flange (A) to casing (B), makes firm, accurate nut plate for attachment to lower flange (C). Rivnut eliminates reinforcing plate. Result: less assembly time, fewer parts, better product.



Rivnut provides 6-thread nut plate for attachment from either end—or *both*. In spotlight assembly, Rivnut replaces awkward welded stud for attaching socket (A). Plug base (B) is attached on other side. Result: fewer operations, lower assembly cost.

TWO JOBS IN ONE OPERATION



B. F. GOODRICH RIVNUTS cut costs and speed assembly because they rivet two parts together, make a firm, accurate nut plate for a third. And they do both jobs in one quick operation! Rivnuts can be installed from one side, take an attachment bolt from either end. They eliminate welding, tapping, clinching.

In the transformer assembly above, one worker fastens the metal cover (A) to the Glastic* sheet (B) with Rivnuts in seconds. Rivnuts then serve as mounting lugs for attaching completed transformer to mounting plate (C).

B. F. Goodrich Rivnuts have speeded up thousands of fastening jobs. They can do the same for you.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten WITH and TO. Explains construction, simplicity of installation. Get your free copy today by writing to: B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. PE-78, Akron, Ohio.

*T. M. Reg. The Glastic Corp.

B.F.Goodrich aviation products

a complete line of HOWARD and New Howard (FORMERLY WESTINGHOUSE) motor parts sets in ratings from 1/200th to 1 h.p.

Illustrated here are a few of the motor parts sets in the complete Howard line. They are currently handling the power requirements of portable power tools, floor polishers juice squeezers and thousands of other widely varied applications. Designed to be built directly into the housings of products and appliances, Howard Motor Parts Sets include armatures and fields, brushes and brushholders, rotors, stators and fans—in any combination, as needed. Whatever your application, there is a standard Howard parts set or variation to match your specifications. If your requirements are in the range of ratings from 1/200th to 1 H.P., check with Howard today.

Now also exclusively available from Howard are the former Westinghouse Motor Parts Sets. Contact Howard for samples and specifications.

SPECIFICATIONS

ARMATURES					COMMUTATORS		
Parts Set No.	No. of Slots	Outside Diameter	Inside Diameter	Core Sizes Available	No. of Bars	Insulation	Hubs
11A	11	1.375	¼ ⅝	¾, 15/16, 1, 1¼	11 or 22	paper, mica, bakelite, or nylon	molded or steel
150	12	1.379	⅜	¾, 1, 1¼, 1½	24	paper, mica, bakelite, or nylon	bakelite or steel
200	8	.960	¼	¾, ⅞, 15/16, 1	16	paper or mica	steel
500	12	1.506	.359	¾, 1, 1¼, 1½	24	paper or mica	steel
700	14	1.812	⅜ ½	1¼, 1½, 1¾, 2	28	paper	steel
900	13	1.600	⅜	1¼	26	paper or mica	steel
2700	7	1.380	¼	1, 1¼, 1½	7 or 14	paper or mica	steel or bakelite

ALL MODELS:

SHAFTS:

Shafts are ground from centers for concentricity. Special flats, worms, etc., can be cut on shafts if required. C.R. Steel is normally used, however stressproof or various types of stainless steels can be furnished if desired.

INSULATION:

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LAMINATIONS:

Laminations are stamped in sets from 24 or 26 gauge improved electrical sheet steel. They are riveted together under pressure in an expanding die. The outside diameter of the field can be ground to customer's specifications. Field coils are wound with heavy formvar copper wire, taped with cotton rayon tape, inserted in field core, then double dipped and baked in an insulating varnish. Field leads can be cut to desired length.

MISCELLANEOUS:

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PERSPECTIVES

in design and development . . .

Making Missiles Versatile

Designing the present-day guided missile means designing for a specific type of mission. The complete missile system is usually defined in terms of this limited objective, behind which lie an operational philosophy, geography and even political factors. Any attempt to use the missile for a different mission requires many changes in the major parts of the system, such as the guidance system or the ground environment. This differs from the design of, say, World War II aircraft where no detailed specific mission had to be known.

Such a close linking of mission, environment, operational philosophy, etc., can only be regarded as a limitation of present missiles. One big result of this design approach is a greater chance of earlier obsolescence of the missile. It can be easily outdated by technical advances, which take place daily, and changes in operational philosophy. Of course the missile designer is close enough to the R & D field to be able to anticipate and incorporate some of the latest technical advances. But he is not in such a position regarding operational concepts, which can suddenly appear without warning—throwing a good design into operational uselessness.

Ronald Smelt of Lockheed Missile Systems Div. says, "While it is desirable that the missile system should be designed to have versatility, it is surprising how little this examination of alternative missions has entered into present missile system development. Practically all of our present systems have an extremely low rating for versatility. While the proponent of piloted aircraft will probably attribute this to the relative inflexibility of the missile's guidance and control equipment, in contrast with the adaptability of the human pilot which it has replaced, this is only a half-truth. Already the basic components are becoming relatively standardized for a whole group of missiles to perform varying missions. The fact is that there have been few attempts to build versatility into our present missile systems, because there has been little demand for such versatility.

New Concept Expected

"But," Mr. Smelt continues, "there are signs of a change in this outlook. In the near future the ballistic missile concept can be expected to enlarge into a complete spectrum of vehicles ranging from moon machines and satellites to offensive and defensive ballistic missiles. There are already a very large number of alternative missions which can be performed by such vehicles, and the number is increasing. As development of the ballistic missile continues, we can expect to find vehicles and systems which are planned from the beginning to satisfy a number of related operational requirements. It may be possible for an offensive ballistic missile system, after minor changes in the direction of larger payload and therefore shorter range, to be converted into a defensive or anti-missile system."

Because the missile designer must work much more closely with the operational groups in the military services than was necessary in earlier aircraft design, he much consider both—technological advances and operational philosophy—in determining new requirements. However, these operational philosophies are usually novel and have not been tried out in the field; in fact, the operational plans are often determined to a great extent by the technical possibilities. This complicates the challenge: specific technical advancements result from definite R & D efforts—which, in turn, are usually the result of a new operational concept. —Paul Anderson

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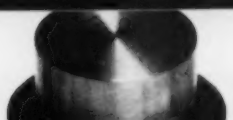


INDUSTRY of DISCOVERY

Moscow has maintained for years that capitalism eventually must succumb to its own cyclical nature, that the violent swings of a profit-motivated economy will sooner or later destroy it. However, no less an authority than Professor Sumner H. Slichter, head of economics at Harvard, has come up with a startling contention that may give the Communist seers pause. In a paper read for him at the National Science Foundation symposium, Professor Slichter pointed out that we are now operating under a new kind of capitalism with stability built in by science.

"Within the last thirty years," Professor Slichter reminded, "technological research has become a large activity that introduces fundamental changes into the operation of the economy. Measured in terms of the number of scientists and engineers devoting full time" to it, research "is more than five times as large as it was in 1930; measured by the ratio of research expenditures to the gross national product, it is about thirteen times as large. . . . Today it is unthinkable that anyone should attempt to construct a theory of employment or a theory of growth without taking account of technological research."

Research for profit is a new factor, according to Professor Slichter. He called it "the industry of discovery" whose "product is knowledge." This product makes the industry operate differently than any other, so that it inverts the law of supply and demand. As the supply of knowledge increases, it tends to demand still more output, rather than less.

"It is obvious that technological research increases the capacity of the economy to raise productivity," Professor Slichter said. "Less obvious and indeed generally overlooked is the fact that research gives the economy the capacity to bring about planned increases in the demand for goods—both by creating new demands for consumption goods and by creating new investment opportunities. . . . It affects the demand for consumer goods by developing new kinds and varieties . . . that people desire to incorporate into their standard of consumption. (It) affects the demand for capital goods in two ways—partly by developing new consumer goods that require new plants and equipment for their manufacture, and partly by development of new processes and new equipment that represents investment opportunities."

Here is Professor Slichter's argument on the effect of research on the stability of economy: "In the first place," he said, "research tends to introduce into many parts of industry the sort of technology that must be financed by long-range plans which ignore the business cycle. In the second place, technological research greatly increases the number of industries in the economy and this in itself is a stabilizing influence. It is difficult, if not impossible, to eliminate fluctuations in the spending of individual industries on plant, equipment and inventories. Hence, each industry has cycles more or less of its own. . . . The important point is that no two industries have the same cyclical patterns or the same sensitivity to outside events. The larger the number of industries in the economy, the greater is the chance that the upward and downward movements of the economy will be sluggish resultants of averages derived from the non-synchronized cycles. . . . Hence, by adding to the number of industries, technological research tends to moderate the cycles of the economy as a whole."

Here is added evidence that our whole economy is changing, and a further indication that it is a technological one. This explains the continuing increase in investment in R & D at a time when business activity, and presumably the amount of money applicable to research, is down. To say it in simple terms, the researcher has become the anchor man of the American economy. His researches are translated into saleable products by the design engineer.

Counterweights, rotating elements and radiation shields from Fansteel and Firth Sterling show how . . .

HEAVY METAL
solves weighty problems

A group of tungsten alloys with a deceptively simple name is tackling complex new jobs. Here's how you can put these high-density materials to work.

ANNESTA R. GARDNER, *Associate Editor*

The jobs now assigned to heavy metal are new as nuclear energy and missiles. Yet the material itself is as old as a grandfather's clock—so old it was almost written off as a dead, or at least a dead-weight, issue until a few years ago. Then, designers began to realize this group of tungsten alloys was good for many things besides counterweights and balance wheels. It also offered a high degree of radiation shielding, high thermal conductivity combined with low thermal expansion, and other useful properties of tungsten—in a form which permits machining and provides a degree of ductility.

What It Is

Heavy metal, in its classical definition, describes a group of high-density alloys containing about 90% tungsten, with the balance copper and nickel, and having a specific gravity of about 17.0 and minimum tensile strength of 80,000 psi. But, until very recently, there wasn't even an official specification covering the "standard" material, much less one for the new alloys now coming along. It was barely 18 months ago, for instance, that the SAE issued its first Aeronautical Materials Specification covering heavy metal (Alloy, Sintered, High-density, Tungsten-base), and the comparable military specification (MIL-T-21014 Aer) is only a little over a year old.

There is need for a standard because no two of these heavy-metal alloys are exactly alike. Even the "standard" 90% alloys show a considerable range of densities. Fansteel 77 metal is quoted at 17.0; Mallory 1000 is 16.7 to

Typical Properties of 8 Weighty Metals

	Cu	Ni	1020 Steel	Pb	Heavy Metal (90% alloy)	Ta	W	Pt
Specific gravity	8.9	8.9	7.9	11.4	17.0	16.6	19.3	21.4
Specific heat, btu/lb/°F	0.092	0.13	0.11	0.034	0.033	0.034	0.033	0.032
Thermal conductivity, btu/hr/sq ft/in./°F	2,680	420	460	240	650	375	1,125	480
Thermal expansion, x 10^{-6} in./in./°F	9.4	7.2	6.7	16.4	3.0	3.6	2.2	4.9
Electrical conductivity, (% IACS)	100	22	17	8	14	14	31	17
Tensile strength soft hard	30,000 45,000	50,000 100,000	60,000 100,000	2,000	80,000 130,000	100,000 150,000	100,000 500,000	23,000 27,000
Elongation, % in 2 in.	20—50	25—40	6—35	50	1—6	50—90	0	3—30
Modulus of elasticity, lb/sq in. x 10^6	16	30	30	2	40	27	50	24
Workability rating	1	2	2	1	4	2	5	2
Price, $/lb	0.25	0.74	0.06	0.12	10	60	8	1,100

17.2; Kennametal, 17.0 to 17.5; Firth-Sterling, a minimum of 16.5 to 16.8 and a maximum of 17.5 to 18.2; and GE Hevimet, 16.9 to 17.2. Furthermore, a number of new alloys ranging from 15.0 to 18.4 are becoming available for special applications.

There Are Many Kinds

Just two years ago, Mallory introduced its Gyromet, offering a proportional elastic limit of 62,000 psi—about 2½ times that of the standard alloy (Mallory 1000).

This increased elastic limit, Mallory says, "permits the designer to utilize a much higher rotational speed along with less rotor mass to achieve a higher inertial moment." It also has the advantage, the company claims, of providing better service at elevated temperatures.

Fansteel is doing its final testing on a 95% alloy which, it says, retains machinability of the basic alloy, but provides greater density (18.4 as compared with 17.0 for Fansteel's standard alloy, #77) and, it is hoped, improved mechanical properties too. (*PE*—Apr. 21, p. 8.)

Going in the other direction—toward a lower tungsten content—in search of increased formability, Mallory has developed an 85% alloy which, it says, can be coined to very close tolerances, "eliminating the need for machining." Designed especially for self-winding watches and other instrument applications, it has a density of 15.0 to 15.3.

Why It's Used

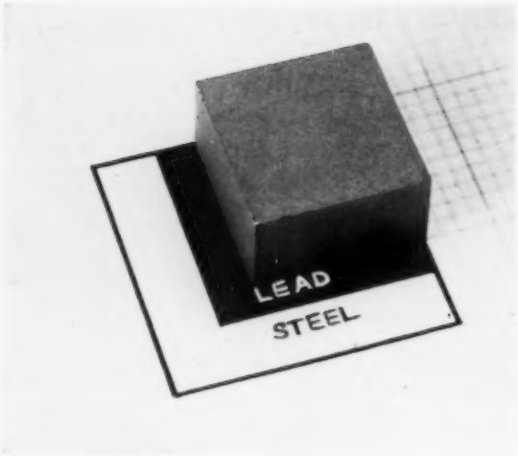
Concentrated weight is the key to many heavy-metal applications. In watches, gyroscopes, aircraft pilot control sticks, and refueling booms, this is primary reason for its selection. Heavy metal weighs twice as much as steel, 50% more than lead.

Of course, if weight alone were wanted, pure tungsten would be the obvious choice. It has a density of 19.3 and its price is relatively moderate. But it is hard to form and harder to machine; and has less ductility. On the other hand, if workability—ability to get the material into the desired shape—were the only consideration, one of the precious metals would be an obvious choice. They're even heavier, and a lot easier to work.

It is the desirable combination of weight and workability plus moderate cost offered by heavy metal that is bringing it jobs ranging from electrical and electronic parts to vibration damping and radiation shielding. The latter ability stems from the fact that radiation shielding ability (on a volume basis) is directly proportional to density—with heavy metal, it is possible to use only two-thirds as much shielding to obtain the same result as lead would give, and less than half of what would be required with steel.

These, Too, Are Plus Values

The corrosion resistance of heavy metal is also good, as might be expected from its composition; and it will



Space savings . . .
possible with heavy metal are illustrated by this photo-diagram. For equal weight or equal radiation shielding, volume would have to be ½ again as great if the block were made of lead; 2½ times as great if it were made of steel.

Machinability . . .
of heavy metal shows in Kennametal component made from a 95% alloy. Turned from a rough compact, it has a 15-20 microinch finish. It demonstrates weight concentration too. Though hollow, only 6 in. dia, it weighs over 50 lb.

resist oxidation, without protection, to at least 750 F.

In the past, heavy metal was used mainly for rather small items—counterweights for gyroscopes, watches, flywheels and governors; stabilizers for milling cutters and boring bars; shields for portable X-ray equipment. But big parts can be made, and an increasing number of them are appearing, particularly for nuclear energy use. Today, 2- and 3-ton heavy-metal items are not unusual.

One reason why heavy metal has had relatively little recognition as a distinct material is that emphasis in its applications is on what it can do rather than specific alloy content. This is, of course, where it should be. If lead or steel will do the job, the designer certainly will and should choose one of those materials. And if some other metal will serve even better, that will be the natural choice.

Another Important Weighty Metal

This fact explains a new and surprising entry in the high-density metal field—tantalum metal (*PE—May 5, p. 6*).

Tantalum has a specific gravity of 16.6 and is much easier to work than any of the tungsten alloys. It's expensive—$55 to $60 a lb as compared with $10 to $12 for the tungsten alloys. But, say tantalum proponents, there are many applications, particularly in today's thin-winged aircraft, where unusually complex counterweights are needed—and they have to be small. If lead were used, the part would be so big it would stick out of the airfoil; yet the tungsten alloys would be almost impossible to form to the required shape, or would be so costly as-formed that they would be out of the question. Tantalum then becomes the natural answer.

Since the basic fabrication techniques for heavy metal, as for tungsten, are those of powder metallurgy, there is a limit to the complexity of forms that can be produced without extensive machining. In general to take advantage of heavy metal's relatively low cost, parts should be held to fairly simple shapes and be given radii of at least 0.010 in. Edges should be chamfered to 45°, and tolerances should not be less than plus or minus 1%. However, when necessary, even long, thin splines can be provided by machining, and tolerances as close as 0.0002 in. can be held.

Who Makes Heavy Metal?

Today, there are at least half a dozen suppliers of heavy-metal rod, bar, sheet, and shapes. Among them are the companies mentioned in this article. Their addresses are:

General Electric Co., Metallurgical Products Dept., Detroit 32.
Fansteel Metallurgical Co., North Chicago, Ill.
Firth Sterling, Inc., 3113 Forbes St., Pittsburgh 30.
Kennametal, Inc., Latrobe, Penna.
P. R. Mallory & Co., Inc., Metallurgical Divisions, Indianapolis 6.

REPRINT of this article can be obtained for your reference file by checking No. E33 on one of the Reader Service cards inside back cover. For other reprints available see "Current Reprints" listing in this issue on page 133.

EDITOR'S NOTE: For more information on unusual metals that can solve design problems, see "Exotic Metals Seek Employment," Mar 17 '57, p 66; "How to Make Invar Stay Put," Dec 9 '57, p 80; "Constant Modulus Alloy for Elastic Elements," July '56, p 135.

Information on familiar materials used for counterweights and similar applications will be found in "Gray Iron Castings," Jan 20 '58, p 52; "A Fresh Look at Leaded Steels," Apr 14 '58, p 72.

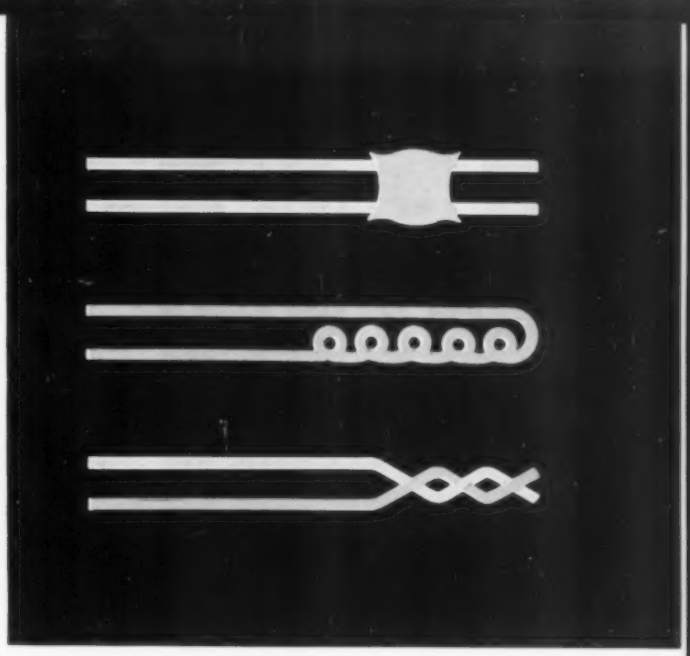
For background information on atomic energy and products that may need radiation shielding, see "Atomic Energy: The Facts," Apr 14 '58, p 52; "Midget Batteries," May 12 '58, p 72.

thermistors?

resistance elements?

thermocouples?

for



TEMPERATURE MEASUREMENT IN SOLIDS

Increased operating temperatures in highly stressed materials call for knowing the exact temperature at the exact point. Here are several ways to get it.

W. H. GIEDT, *Senior Research Eng., D. L. RALL, Research Eng., Detroit Controls Corp.*

It is possible today to install a precision temperature probe in a metal plate–within 0.003 in. of desired position. Although this requirement is unusual (and expensive), it shows the continuing trend towards more accurate measurement of temperature.

The sensing elements that measure temperature in solids are available in three common forms: thermistors, resistance-type thermometers, and thermocouples. **Thermistors** and **resistance** elements experience change in electrical resistance with change in temperature, and require bridge circuits for reading. **Thermocouples** generate their own electrical potential when heated (the Seebeck effect). Any of the three will do an adequate job when transients are slow, temperatures are moderate, and gradients (temperature vs distance) are gradual. Special care in selection is needed if much temperature difference will occur across the plate or other solid shape being instrumented. The probe should then be accurately oriented so its sensing area does not straddle different temperature planes: the junction should remain in plane normal to heat flow. It must also be compact and have little resistance to heat flow. In extreme situations where surface melting may occur, a series of sensing elements can indicate rate at which the surface recedes.

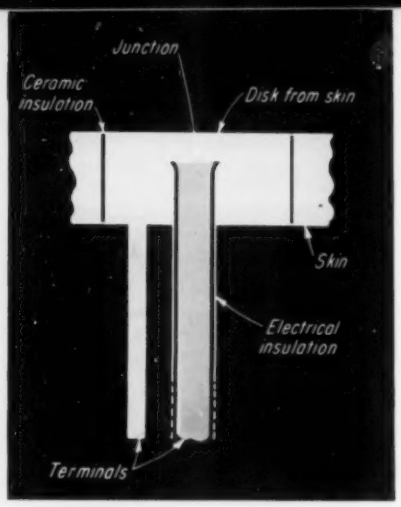
Significant temperature gradients across the instrumented body can be expected if the ratio hL/K, the Biot modulus, is greater than 0.2. Here, K is thermal conductivity of the body in btu/hr/ft/°F; L is shortest dimension of body, ft; and h is surface heat transfer coefficient, btu/hr/ft²/°F.

A simple rule for estimating maximum size and orientation of a sensing element is to use as a guide the distance between two points within the body over which the temperature change equals accuracy of the measurement.

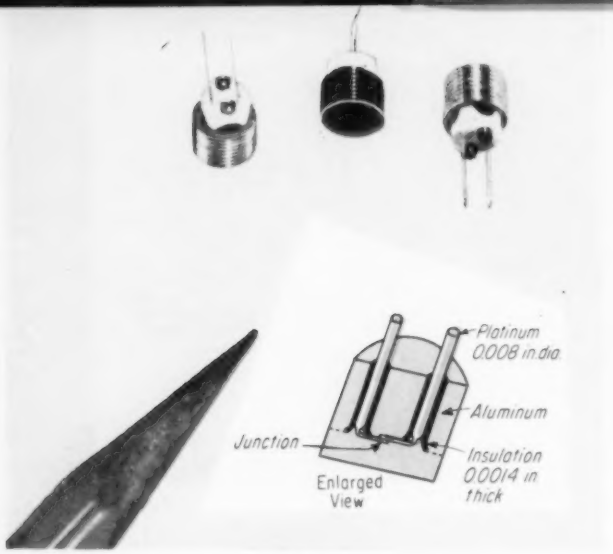
I–THERMISTORS

The thermistor, a resistance element made from semiconductor materials, has a very high negative coefficient of resistance. As temperature rises from 0 to 600 F, the resistance may decrease by a factor of 1000. By contrast, platinum–not a semiconductor–increases in resistance by a factor of about 2 over same temperature range.

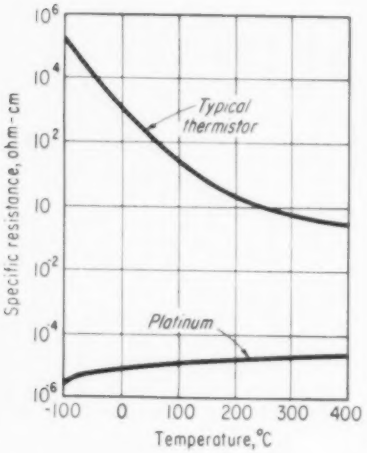
Common semiconductors for thermistors are metal



Skin metal . . .
in form of small disk is half of the thermocouple junction here. Terminal on right is thermally similar to disk but produces electrical potential proportional to temperature at junction.



Thermocouple is embedded . . .
in threaded plug small enough to screw into thin wall. Region below junction (indicated by dotted lines) is thin plate resistance-welded to upper part after junction has been installed.



Thermistor is distinguished . . .
by high negative coefficient of resistance. Reverse is true with platinum resistance element but it will withstand more severe temperatures.

oxides of nickel, manganese, iron, zinc and cobalt. Thermistors are available in bead, rod, disk and washer form with minimum thickness about 0.01 in. Leads may be molded directly into the element or soldered on after wiring. Disks and washers have an additional advantage: They can be plated on opposite faces and mounted between flat metal contact surfaces.

II—RESISTANCE ELEMENTS

Resistance thermometers have long given a standard way to measure gas and liquid stream temperatures. One recent application is a resistance coil of 0.001-in.-dia platinum wire sealed with ceramic cement in an 0.04-in.-dia Inconel tube. It measures temperatures in turbine blades.

Resistance thermometers similar to strain gages are available for indicating surface temperatures. They are made by mounting a grid of very small-dia wire between two insulating strips. Such gages are easily bonded to accessible surfaces, but are limited by max allowable temperature of insulation and bonding cement.

Surface temperatures of a nonconducting material can be determined from the resistance of a thin metal film deposited by painting or vapor plating. This technique has proved useful for very rapidly changing conditions such as occur in shock tubes.

III—THERMOCOUPLES

The thermocouple has some size and performance advantages over thermistors and other resistance elements. Because it is more compact and gets by with thinner insulation, it can be more accurately positioned and made to respond to temperature changes almost instantly. Thermistors are not yet as suitable for wide temperature ranges; and neither they nor other resistors respond faster than $\frac{1}{2}$ sec.

The thermocouple junction should produce a readily measureable emf. And its elements should be similar in thermal conductivity, specific heat, density and expansion coefficient to the metal whose temperature is being measured. There are two ways to make the junction.

1. Usually a junction consists of two wires (such as iron and constantan) embedded in the metal. The thermocouple will probably have thermal properties different from those of the parent body, but trouble can be avoided by making the thermal capacity very low. This, of course, requires a very small thermocouple as well as small leads.

2. Or—a piece of the solid material being instrumented (such as the wall of a combustion chamber) serves as half the junction. The other half must be

Performance of the 3 Temperature-sensing Methods*

Method	Possible Temperature range, °F	Typical output	Min error, %	Cost			Min dia, in.		
				Mtls.	Mfg.	Install.	Bare	Insul.	Encased
Thermistor	−200 to 900; poor stability ≥ 350	$-0.03 \frac{\text{ohm/ohm}}{°F}$ (room temp.)	1.5	low			.....	0.01 (bead)	.....
Metal resistance element									
Standard	−460 to 2000	$0.002 \frac{\text{ohm/ohm}}{°F}$ (room temp.)	0.1	moderate		moderate to high	0.001	0.005	0.04
Special	−460 to 5000								
Thermocouples									
Metal-to-metal	−460 to 2800	$\frac{\text{microv}}{°F}$							
Carbon-to-silicon carbide	−460 to 5000	$180 \frac{\text{microv}}{°F}$ but resistance is high	0.4	low			0.001	.....	.....

*All values approximate; environment and installation will influence readings.

electrically insulated from the body everywhere except at the junction. This type has been used for measuring temperature distribution in metal-cutting tools.

SAFEGUARDS NEEDED

Insulation and bonding materials are usually required. Resistance elements and thermistors, because their resistance is affected by impurities, need the most protection. Organic insulation materials such as silicon compounds, woven glass, and fluorocarbons are adequate to about 425 F. For temperatures up to about 900 F, ceramo-plastic materials such as glass-bonded mica will suffice. Above 900 F, use ceramic materials such as Al_2O_3, MgO, ZrO_2, and Sauereisen compounds.

Oxidation of the surface of some thermocouple wires will provide adequate electrical insulation, yet permit fairly good heat flow. In one example (for measuring gun-bore temperature during firing) a nickel wire terminal is oxidized, then swaged (encapsulated by deforming the metal around it) into a plug of the parent metal. The actual junction is formed by electroplating or vapor-plating the polished tip to bridge the nickel oxide insulation.

Temperature limits are affected both by type of insulation and size of element. An insulated Chromel-Alumel junction using wire 0.128 in. in dia (B & S #8 gage) will operate satisfactorily up to 2300 F, yet the same junction metals uninsulated and only 0.001 in. in dia (B & S #30) are limited to 1300 F. This is because the combination of insulation and heavy gage will lengthen time before the couple breaks or fails from corrosion and other effects.

Other Thermocouple Pairs

JUNCTION MATERIALS		RESPONSE,* MICROV °F
chromel	constantan	40
iron	constantan	31
chromel	alumel	22
tungsten	graphite	15 (300 to 2400 F)

* Approximate slope in 0-1800 F range

EDITOR'S NOTE: More details on thermistors are found in several previous articles. Three of them, "Characteristics of Thermally Sensitive Resistors," May '56, p 378; "How to Use Thermistors," Apr 54', p 200; and "Which Thermistor," Mar 54, p 182, thoroughly describe function and uses of thermistors, including temperature measurement, control and communication. A graphical solution of the logarithmic equation of resistance vs temperature is plotted in "Thermistor Nomograph," Mid-Oct. '55, p 1-22.

Thermocouples, resistance elements, and thermostats were covered in articles including: "Some Thermocouple Details for Temperature Measurement," Aug '51, p 166, thoroughly describes most of the common junction configurations and provides detailed performance data for many metal pairs; and "Temperature-measuring Devices," Feb '50, p 138, compares bulb, bimetal, thermocouple, pyrometer, resistance and melting-cone types of sensing elements.

NEW HARDENABLE TITANIUM

for springs, aircraft skins, pressure tanks, rivets and bolts, and honeycomb

Age-hardening alloy developed by Crucible Steel Co. of America and designated B-120VCA combines high strength (up to 240,000 psi), corrosion resistance of pure titanium, service temperatures of 600 to 800 F, and the highest strength-weight ratios available.

ROBERT W. CARSON, *Managing Editor*

This new titanium alloy B-120VCA, available in sheet and wire, can be formed in the ductile annealed condition and then hardened by simple aging treatment. It is precipitation hardening—as are duralumin, PH17-7 stainless and beryllium copper. Final combination of strength and ductility is controllable over a wide range by choice of heat treating temperature and time.

One of several new precipitation-hardening alloys developed by Crucible Steel, B-120VCA is an "austenitic" type with 13% vanadium, 11% chromium and 3% aluminum. In its formable (annealed) condition as supplied it has a yield strength in the range of 120,000 to 135,000 psi, with 10 to 15% elongation. Rod can be cold-headed for rivets, and parts can be brazed or welded. Bend radius at room temperature can be as sharp as 3 times the thickness; warmed to a temperature of 200 to 300 F, bend radius can be reduced to twice the thickness.

Simple Hardening Process

Hardening is induced by simple heat treatment at 850 to 900 F in air for 50 to 100 hours. Dual-temperature heat treatments under development promise to reduce these times by a factor of 5 or 10. Hardening time is only moderately affected by the amount of cold work induced during forming.

Hardening proceeds at a varying rate characteristic of other precipitation-hardening alloys. Response—as measured by tensile strength—starts slowly, increases fairly rapidly with increased time, but slows down well before reaching a maximum. Considerable additional time may bring some loss in strength. The time required to first reach maximum is not critical, and may vary by 10% or more with little effect.

Higher hardening temperatures yield higher strengths with shortened heat-treating time—again characteristic of other precipitation-hardening alloys. Also, ductility is less with the heat treatments giving higher strength. The relationship between increase in strength and decrease in ductility, however, is not completely parallel. This offers promise for dual-temperature heat treatments that may both shorten the hardening time and give somewhat better ductility at high strength.

Single-temperature heat treatments presently recommended can produce the following range of properties from the same material by varying time and temperature.

Ultimate strength, psi	*Elongation, %*
190,000	6
200,000	5
210,000	4
220,000	3
240,000	2

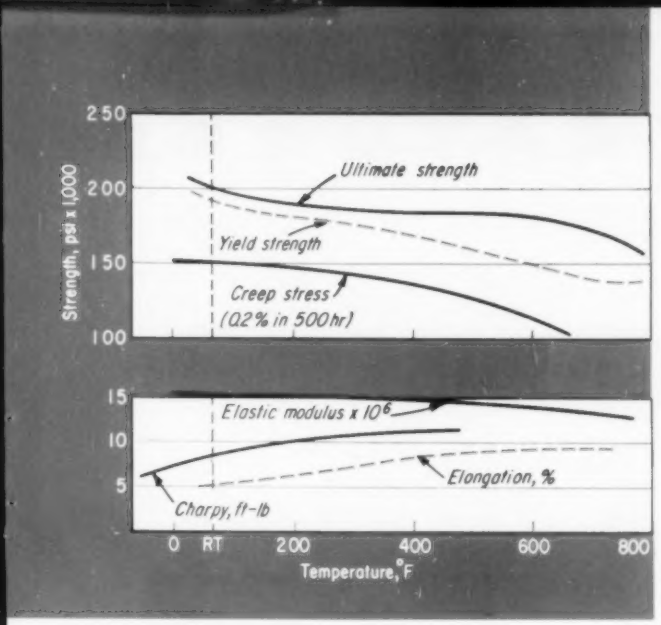
The heat treatment required to produce the highest strength is 72 hr at 900 F.

In development work now underway on dual-cycle heat treatments, specimens from 0.3 x 0.10-in. ribbon have been heat-treated to 257,000 psi with 3.1% elongation. Hardening response in 12 specimens taken at 2-ft intervals showed a standard deviation of only 6500 psi and 0.6%, indicating good uniformity in response to the heat treatment.

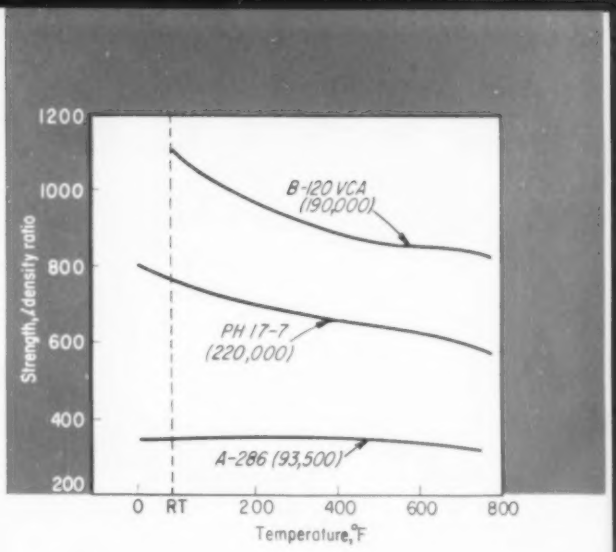
Elevated-temperature Properties

For long-time exposure to heat, max temperature must be kept below the hardening temperature to avoid change in properties that would come with further heat treatment. For material heat-treated to 200,000 psi ultimate and 5% elongation, tensile properties at elevated service temperatures are shown in the accompanying curves.

For the same material and heat treatment, creep stress for 0.2% plastic deformation in 500 hr decreases with temperature at a slightly faster rate than does the ultimate tensile strength. Note also that charpy impact values show characteristic small increase with higher temperature.



Elevated service temperatures . . .
give these tensile characteristics for B-120VCA heat-treated to 200,000-psi ultimate.



Strength-density ratio . . .
for B-120VCA at temperatures up to 800 F is superior to that of PH17-7 hardenable stainless and A-286 titanium. Values in parentheses are for 0.2% offset yield strength at room temperature.

Physical Properties

In the solution heat-treated condition the elastic modulus is 14.3 x 10^6, a little lower than for pure titanium. During hardening, the modulus increases to 15.3, approximately the same as for the pure metal. There is the usual small decrease in modulus with increasing temperature–about 1% for each 60° F.

Density is 0.175 lb/cu ft, or about 7% heavier than for pure titanium. Thermal conductivity is 3.9 btu/hr/ft²/°F/ft, or about 40% of the value for pure metal. Thermal expansion is the same as for pure metal.

Corrosion resistance for the heat-treatable alloy, according to preliminary tests, is the same as reported for other titanium grades.

Fabrication

Because of the higher ductility of the solution-treated alloy, smaller bend radii generally can be used than are recommended for the standard A-70 grade. Many operations that would require forming at elevated temperatures with other titanium alloys can be carried out at room temperature with B-120VCA.

An important advantage of the new alloy is its ability to take cold heading in the soft state and then undergo hardening. This makes it possible to cold-forge rivets and bolt heads with a large saving in material and machining time.

Machinability is the same as for other titanium alloys but usually is not a major factor in producing parts from sheet stock. In general, it is handled about the same as stainless steel sheet.

The new alloy can be drawn into wire and coiled into springs by methods common with stainless. Tendency to distort during hardening appears to be comparable also.

Ductile welds can be made in solution-treated material if the weld is properly shielded from air contamination. Weld metal shows about the same ductility and strength as the base metal. However, the weld metal tends to age at a different rate than the base metal.

Sheet is free from directional properties, with no evidence of shear cracking; it is apparently unaffected by hydrogen. It can be brazed by usual methods and made into honeycomb.

Lightweight Design

While the exceptional combination of corrosion- and heat-resistance of B-120VCA is perhaps the most important characteristic for industrial applications, the low density adds an important weight-reduction opportunity for aircraft and spacecraft. In this area the strength-density ratio is substantially higher than for any other alloy within its temperature range.

Price of B-120VCA is somewhat higher than for pure titanium, which still is costly even though there have been substantial price reductions in recent months. In sheet form the material cost is many times that of 18-8 stainless. But in many small parts doing important jobs the metal cost often is not a major factor. This new alloy therefore offers promise where a high-strength part is subjected to corrosion and heat or where weight saving is essential.

EDITOR'S NOTE: For a review of 26 new areas of development in materials and processes, including new uses for titanium alloys, see "Bellwether With Wings," July 7, '58, p 52. For articles in earlier issues see listing under "Titanium" in annual indexes.

Forming problems are discussed in "Hot Finish-forming Ti," July '57, p 146, and editor's note at end of the article lists five earlier ones discussing forming, welding and forging. An article in the coming Design Digest Issue will include data on high-temperature properties of titanium.

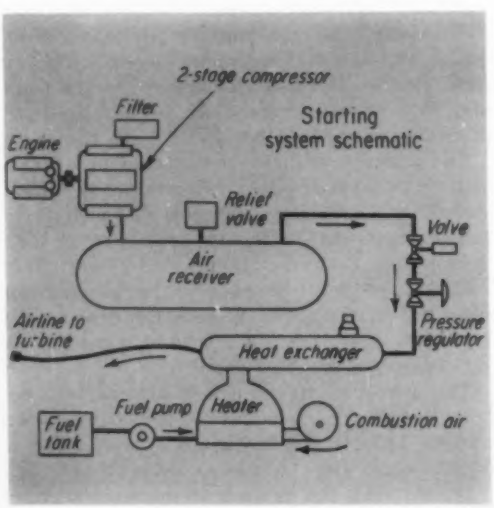
PACKAGED AIR STARTS TURBINES

Commercial components went into this stored-air system—built as mobile unit for starting commercial or military gas turbines. Same engine powers its air compressor and propels the carrying vehicle.

The photo shows one of the units delivering warmed, compressed air to start up a turboprop airliner. "Air-Torq" is manufactured by Pre-Flite Industries Corp., Paramount, Calif. It was designed to operate at low speed and power requirements, eliminating objectionable noise produced by high-speed starting systems.

Self-propelled cart . . .
has 6-cylinder, 104-hp engine that drives both the vehicle and its 2-stage, water-cooled compressor. The work required, to compress large volume of air needed, is spread over longer period of time by using air receiver—a welded steel vessel built to ASME standards.

The high-pressure air is bled through tubular heat exchanger which delivers it to turbine at required starting temperature. Air can be heated to 500 F. Starter operates from −45 to 130 F, up to 7500-ft altitude, and at 100% relative humidity.



Starting a turbine . . .
is relatively simple operation. Engine is connected to compressor through mechanical power take-off. When receiver pressure reaches 550 psi, compressor unloads and engine drops to idle. Line from air output is attached to gas turbine. Pressure regulator is set for specific turbine needs. Master switch and preheat button activate heater for heat exchanger. At completion of preheat cycle, starter switch vents starting air through pressure regulator and heat exchanger to start turbine.

IN NEW PRODUCTS

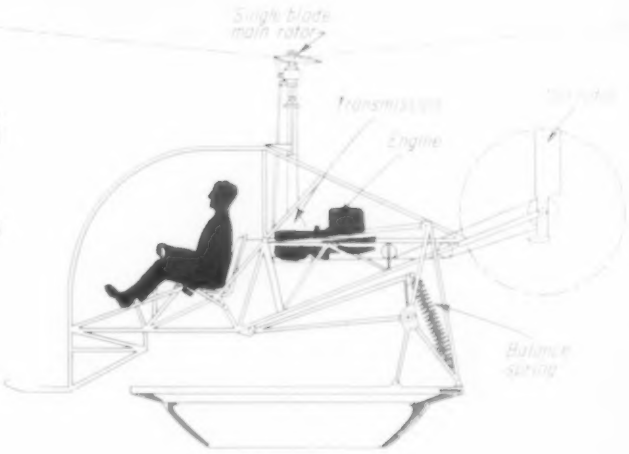
CONTROLS FLY TRAINER—ALMOST

The simulated helicopter can't actually take off. But its powered rotors and controls are real. When float-mounted, it gives the student a real tussle with troublesome pitching and rolling.

This primary trainer has a single-blade main rotor, was designed to replace teaching with a dual-control flying trainer or with expensive electronic simulators. It cuts pre-solo time for hovering in half, and pre-solo for precision approach by 25%. Both the trainer, and a proposed 1-man copter based on same concepts, are in the low-cost category—$18,000. Designer is Hans Derschmidt of Boelkow Entwicklungen, K. G., Stuttgart, W. Germ.

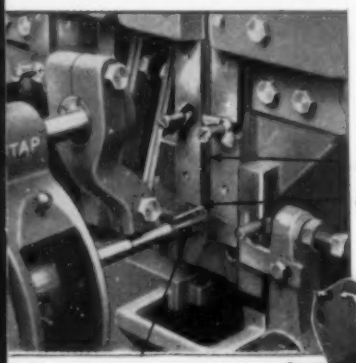
Student learns . . .
in three stages. For first two, trainer is pivot-mounted. First comes vertical motion—student learns operation of main-rotor pitch control and twist-grip throttle. Rotor thrust balance springs can lift trainer only 40 in. For second stage, trainer is free to rotate; student learns control of tail-rotor pitch by rudder pedals.

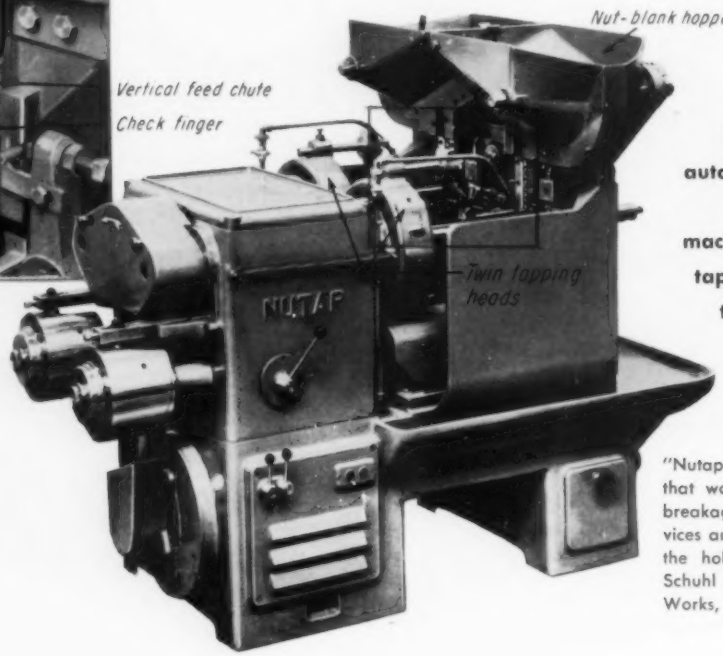
He's now ready for final phase—on water, with trainer mounted on circular float. This gives practice in hardest job—control of pitching and rolling by control stick connected to swash plate. Projecting edge on float limits tipping motion.



Rotor assembly . . .
is rigid; consists of single blade, counterweight and connecting arm. Complex gearing is eliminated by using simple cardan joint to connect rotor drive shaft; single control rod connects swash plate and rotor. Trainer is powered by 18-hp, 2-cylinder engine driving rotor at 455 rpm.

TAPPED NUTS GUIDE THE TAPPER

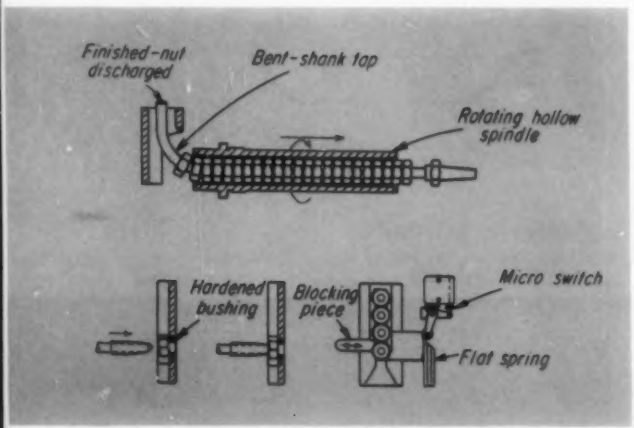




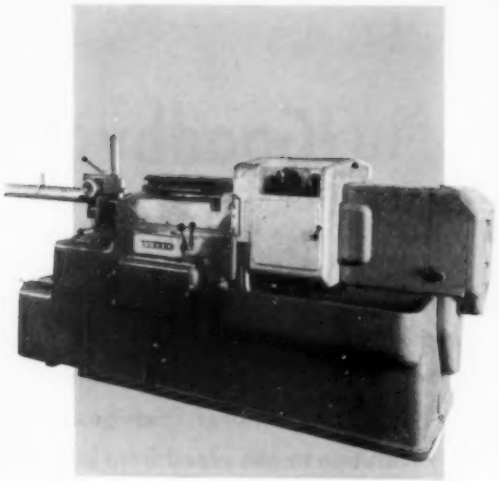
The nuts finished by this automatic tapper have work to do before leaving the machine. By supporting the tap, they help give accurate threading to blanks that follow.

"Nutap" has rotating double spindles that work alternately. To reduce tap breakage and wear, it uses safety devices and free passage of nuts through the hollow spindles. Manufacturer is Schuhl and Von den Steinen Machine Works, Hagen-Westfalia, W. Germ.

Gravity feeds . . .
nut blanks out of hopper and down vertical chutes to be checked by mechanical finger. Finger stops tap from advancing if it meets an obstruction or defective blanks. Supported inside spindle by finished nuts, tap with bent shank penetrates satisfactory nut blank and completes tapping. Nut then pushes through spindle and up along tap shank, until discharged.



Hollow spindle . . .
is filled with finished nuts that string themselves along the bent-shank tap and support it concentrically. Accuracy also results from tap advance corresponding to exact pitch of thread. Clamping device positions nut blank during tapping, but does not grip it tightly. Advancing tap pushes nut against thrust plate—at right angles to tap axis—producing thread perpendicular to nut bearing surface Miniature precision switch stops machine if tap is overloaded.



VERSATILE LATHE CUTS TOOL COST

Traveling headstock of the single-spindle automatic lathe can machine long workpieces to close tolerances.
For most of its operations, single-point tools replace expensive form cutters.

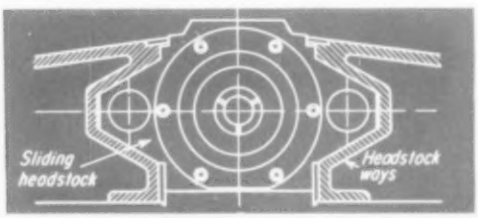
Work up to 12 in. long is handled by 6-position turret and double cross-slides. By using rotating spindles in turret, drilling, tapping and threading are possible. The lathe is produced by Tavannes Machine Co. SA, Tavannes, Switz.

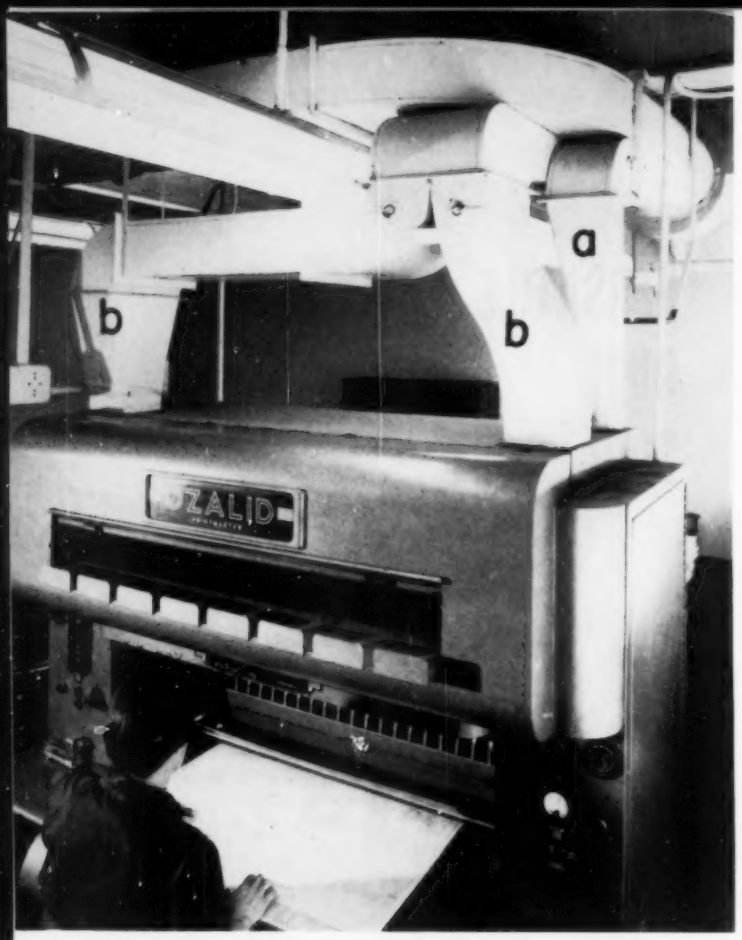
Working cams . . .

are reduced to four in number and arranged vertically at rear of machine for accessibility. Flat cams operate headstock, cross slides and turret spindles. Turret cam is calibrated for quick adjustment of spindles. Centralized lubrication pump services all essential points automatically.

Massive headstock ways . . .

and rugged cross slides allow using carbide-tipped tools. Guide bushing, driven at same speed as headstock, supports workpiece in work area, providing rigid support during machining. Three tools on each cross slide are accurately adjusted by individual micrometer stops. Bar stock is fed through collet by holding bar and withdrawing headstock.





Ducts were added . . .
at both ends *(b)* of machine, supplementing existing exhaust duct *(a)*. Because of this enlarged capacity, offensive gas no longer invades print room.

Goodby to

Annoyance was banished from this setup by additional vents and a switch-over from gas in solution to gas piped from bottles. Ammonia now stays where it should—in print-developing machines.

HAAKON JOHNSON
Chief Draftsman
Radiation Laboratory
University of California

The pungent nuisance of ammonia fumes is familiar to anyone passing close to most ammonia-developing print machines. And like the stubborn southern California smog, it has often been regarded as an occupational hazard with no simple answer. Print-machine operators in University of California's Radiation Laboratory at Berkeley were literally crying for help. Extensive building alterations had reduced the fume dissipating area from 11,000 to 800 sq ft. As a result, only one of the two 42-in. machines in their print room could be operated at a time—and that for only part of the day—without raising fume density beyond tolerance level. Then UCRL engineers worked out two simple modifications. These not only remove all traces of the offending fumes but eliminate need to handle aqueous solutions when more ammonia is needed.

Venting Capacity Is Boosted

Two ways of venting fumes were proposed: (1) install a forced-draft ventilation system in the print room; or (2) increase capacity of the conventional machine exhaust system. The latter was chosen because the need was urgent and this method was simpler.

Two 4-in. holes were cut in the top of the housing at the two ends of each machine. These were connected in parallel with existing exhaust ducts. Connections were generously proportioned to avoid the possible necessity of increasing size at a later date.

Each new duct has a damper which has since been operated in a partially closed position, indicating that a somewhat smaller duct could have worked. The machine's normal exhaust system is not materially affected by the additional vents.

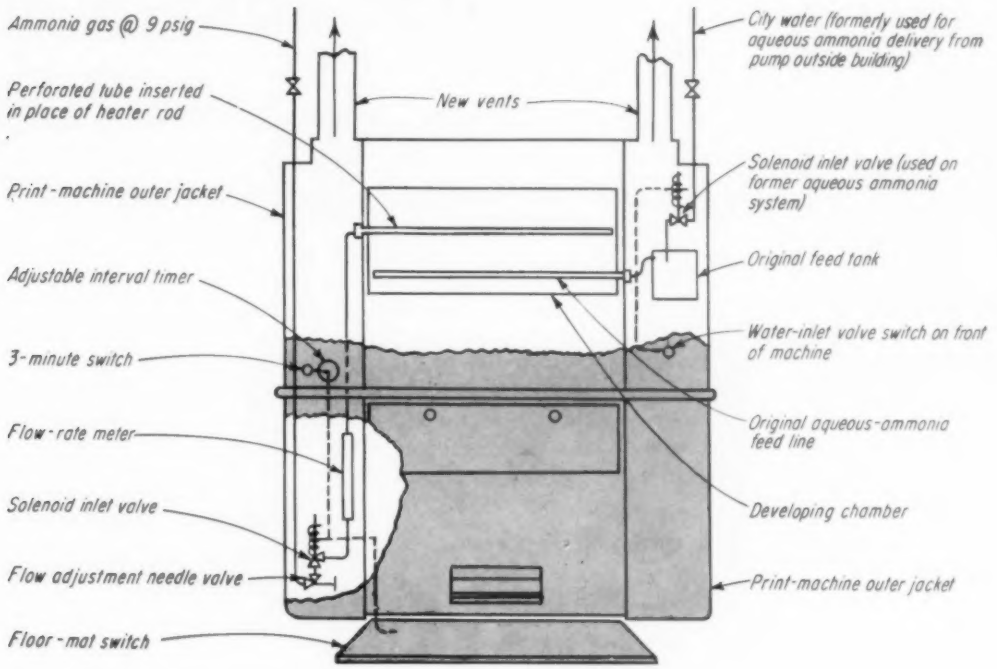
After 18 months' operation, even the most sensitive persons have been unable to detect fumes in the print room.

What About Refill Fumes?

Transferring aqueous ammonia to the print machine is not only a potent source of fumes, but also a continual annoyance to machine operators. The original system in which the solution was gravity fed or pumped from glass containers into the top of the machine resulted in spillage and an occasional broken container —a nuisance and unpleasant experience for those who had to mop up ammonia solution while wearing a gas mask.

The first try at solving this problem involved in-

Ammonia Fumes in the Print Room


Ammonia gas @ 9 psig
Perforated tube inserted in place of heater rod
Print-machine outer jacket
Adjustable interval timer
3-minute switch
Flow-rate meter
Solenoid inlet valve
Flow adjustment needle valve
Floor-mat switch
New vents
City water (formerly used for aqueous ammonia delivery from pump outside building)
Solenoid inlet valve (used on former aqueous ammonia system)
Original feed tank
Water-inlet valve switch on front of machine
Original aqueous-ammonia feed line
Developing chamber
Print-machine outer jacket

Improved design . . .
substituted bottled ammonia gas (left) for aqueous ammonia solution. Solenoid valve and floor-mat switch stop gas flow when operator is not at work position in front of machine.

stalling two 55-gal. drums of aqueous ammonia just outside the building, about 100 ft from the print room. A small electric pump delivered the ammonia through a solenoid valve on each print machine. A single switch started pump and opened valve. This worked fine when vapor lock did not interrupt the flow—which was not uncommon during the several years the system was in operation. Relocation of drums and piping to a cooler, more sheltered location might have solved the vapor lock problem but, instead, a system using bottled ammonia gas was proposed and later adopted.

Gas Goes to Work

A heater rod (one of several normally used to heat the aqueous solution so it would liberate ammonia gas) was replaced by a perforated tube running full length of the machine.

Bottled gas is piped to this tube through a solenoid valve. To provide the proper moist atmosphere, city water replaces ammonia solution in the developing chamber and is heated by remaining heater rods. The solenoid valve on the ammonia feed is connected to a timer switch and a floor-mat switch in parallel. With this arrangement, gas flows in only when an operator stands in working position in front of the machine. And the timer switch allows operator to "warm up" the machine prior to a run, avoiding delays while waiting for the developing chamber to fill with gas.

Prints made with gas are not significantly different from those developed by the regular process. Intermediate prints require a moist atmosphere in the chamber for good results, while gas without moisture is usually sufficient for normal prints.

Less Fading—Lower Cost

Experts advised that prints developed without moisture would be more sensitive to fading than prints made the usual way. To test this, prints made by both methods were posted on a west window and exposed to sunlight through the glass for a period of six months. Both prints faded, of course, but they were both still readable and the gas-processed print was slightly more legible.

With these modified machines in daily use, the cost of ammonia gas has averaged $2.45 compared with $3.95 per day for the conventional feed. Maintenance costs are lower too. In 18 months, machines have had negligible down-time for repairs.

NEW SUPER ALLOY BIDS for HOT JOBS

It's in the range from 1200 to 1800 F that Rene 41, in sheet form, claims superiority. Here are facts and curves comparing it with other high-strength alloys.

F. KENNETH IVERSON, *Chief Metallurgist*
M. A. POHLMAN, *Metallurgist, Special Products, Cannon-Muskegon Corp.*

A new member named Rene 41 has joined the growing family of high-temperature superalloys. Its high strength spans a wide temperature range and is especially valuable between 1200 to 1800 F. Also noteworthy are these important properties:

- Improved stress rupture strength
- Good ductility and formability
- Low distortion
- Good weldability
- Resistance to corrosion

When precipitation-hardened, its higher tensile strength makes this nickel-base material the strongest superalloy obtainable in sheet form. (Strength values for bar and rod are slightly higher.)

Compared with Castings

Some of the newer cast superalloys are stronger than this sheet material, but their ductility is lower and they show a wider spread of mechanical properties. This scatter often makes them less reliable and, consequently, may bring their guaranteed properties lower than for wrought alloys. Furthermore, castings cannot be formed into lightweight sheet products, such as honeycomb, when a high stiffness-to-weight ratio is desired.

Other Comparisons

Above 1800 F the cobalt-base superalloy L605 has equivalent strength in sheet form, but at 1000 to 1800 F its yield strength is only half that of Rene 41.

Although the new alloy offers high strength throughout a wide range of temperatures, it is not economical when needs remain below 1000 F. From room temperature to about 400 F, the low-alloy steels like 4340 excel for their high ultimate strength—above 250,000 psi. From about 300 F up to 900 F, the hot-work tool and die steels have tensile strengths of about 200,000 psi. By comparison, Rene 41 has about 180,000-psi tensile strength throughout the range from room temperature to 1000 F.

Its improved rupture strength is about 10% higher than for Hastelloy R, the next best superalloy available as sheet. But at 1800 F this difference is reduced to about 1,000 psi, which is within the limit of accuracy of testing.

These mechanical properties show that, where stress rupture is the main consideration, the slight superiority of Rene 41 over Hastelloy R will not radically change shape or design. However, for short-time applications, the 60% increase in yield strength makes redesign possible, even desirable.

Substituted in parts designed from superalloys other than Hastelloy R, it extends mechanical properties and allows the parts to stand up to temperatures higher than before.

Workability Data

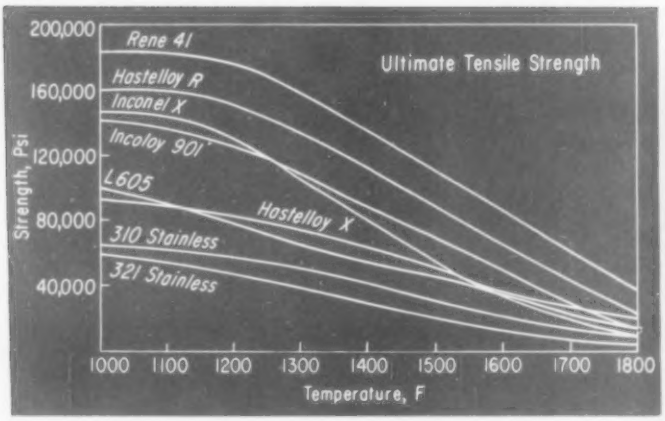
Although readily formed and machined, it is slightly less machinable than Inconel X. In sheet metal forming—bending, braking and spinning—Rene 41 takes the same deformation as 18-8 stainless steel, without cracking. However, working the new alloy requires more power because it has a slightly higher yield strength and also more springback. Room-temperature properties of Rene 41 annealed for working are:

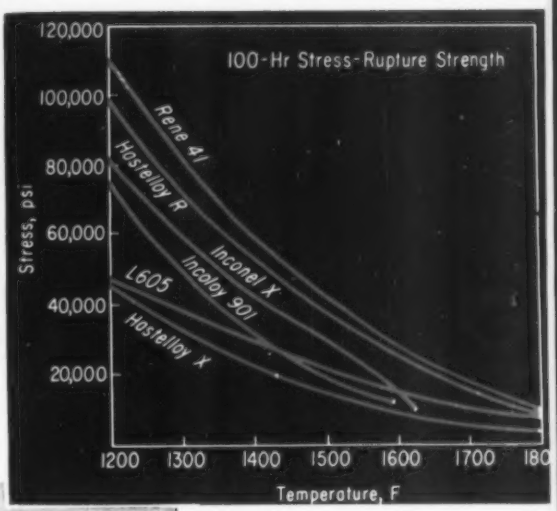
Ultimate tensile strength	134,000 psi
0.2% yield strength	77,000 psi
0.02% yield strength	55,000 psi
Elongation	48%
Hardness	Rc 22

For process annealing, Rene 41 should be heated rapidly to 1950 F, held and quenched rapidly. Lower solution temperatures or slower cooling cause an age hardening which lowers ductility. Because this alloy has low warping, the rapid cooling gives little distortion.

Although the alloy is readily weldable by helium-gas tungsten arc processes, current should be kept to a minimum to insure a narrow heat-affected zone. The gas allows a 50% reduction in welding current. Other welding tips:

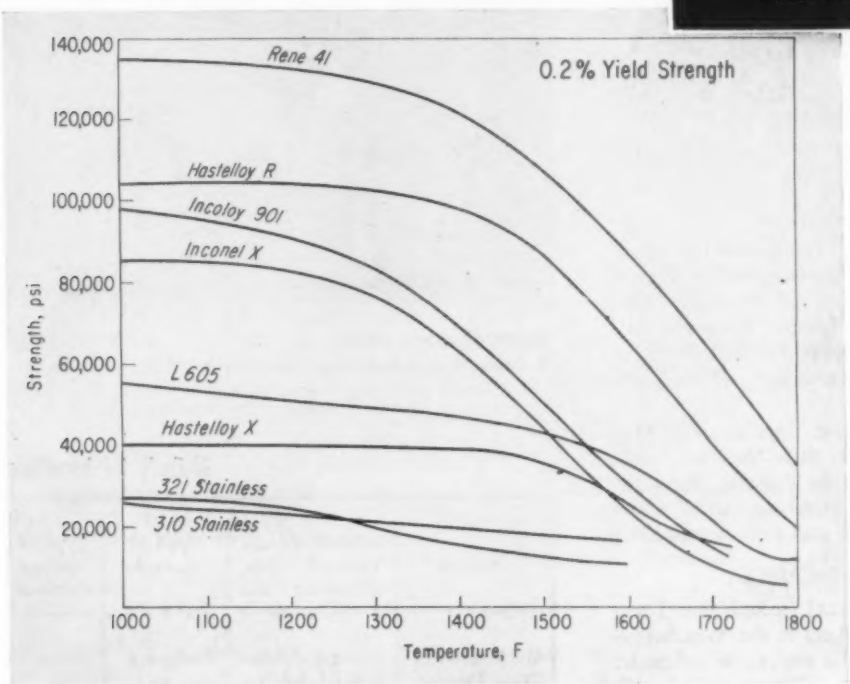
- Use minimum restraint
- Back up with copper and gas
- Solution-treat all welds, heating and quenching them rapidly.





Tensile Properties of Superalloys at Elevated Temperatures

(curves are for precipitation-hardened sheet material)



Corrosion Effects

Oxidation-resistant up to 1800 F, the alloy loses less than 1 mil in 100 hours. Normal process annealing in air is not harmful. But for long periods of service above 2000 F, this material is not recommended because of detrimental intergranular attack.

Size and Price

Sheet down to 0.010 in. thick is available up to 48 x 120 in., and foil down to 0.001 in. can be obtained in widths of 8½ in.

Present prices, $8 to $10 per lb, are high because of limited production. When production is stepped up, the price for this material should be about the same as for other vacuum-melted, high-strength nickel alloys.

EDITOR'S NOTE: Additional information on other high-temperature materials are discussed in:

"Titanium Carbide," Nov 11 '57, p 84, compares mechanical and physical properties of TiC with superalloys.

"High-temperature Stainless," Apr '57, p 135, compares mechanical properties and structural stability of eight stainless steels between 600 F and 1400 F.

"Nitride-bonded Silicon Carbide," Feb '57, p 135, describes specially bonded ceramic with improved hot strength and resistance to abrasion and corrosion.

"Metals at Elevated Temperatures," Oct '56, p 186, discusses basic design questions for materials at elevated temperatures.

"High-temperature Materials," Sept '56, p 186, reviews early developments, alloy systems used, properties required, methods of evaluation, and trends.

DRUM CAMERA

best way to

put motion on record

Under its quick and reliable eye, fast-moving parts show a "cardiogram" of their acceleration and velocity that can be read quickly off curves. Author compares drum camera with its three rivals.

Dr. KARL MAIER

Manager, Advanced Research and Development Dept.
Olin Mathieson Chemical Corp.

The drum camera is an ideal instrument for recording dynamic behavior of rapid-moving parts—it combines simplicity, speed, accuracy and versatility. One of the four modern methods available, it's not as well known as the others because it cannot be bought off the shelf. But it has proved its superiority in analyzing gun recoil and spring dynamics.

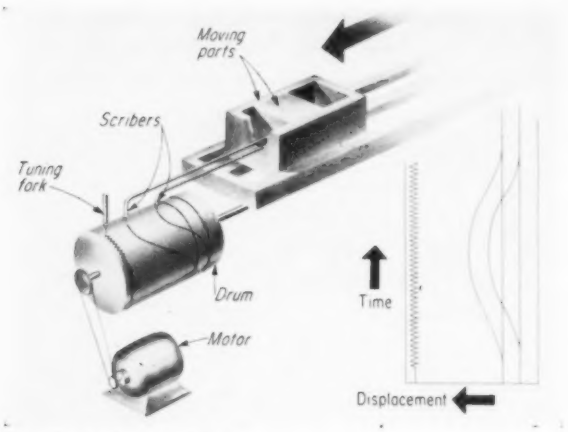
For example, one of the other three methods—the high-speed movie camera—gives an intermittent record that is difficult to interpret. By contrast, the drum camera gives a continuous optical record in which velocity and acceleration can be read directly off curves.

ELEMENTS OF THE CAMERA

Such T-D (time-displacement) records are being obtained with a drum-type camera at the Winchester-Western Division, for kinematic analysis of automatic guns. Moving parts to be studied are provided with special vertical light-reflecting markers, such as white painted lines, concave grooves machined into the parts, or soldered-on short cylindrical pins. These markers are illuminated by a bright light source and send reflected light beams through the camera's objective lens.

The shutter remains open; beams pass through the longitudinal slot, and the cylindrical condensing lens focuses them on the surface of the rotating drum. This produces traces of the moving points.

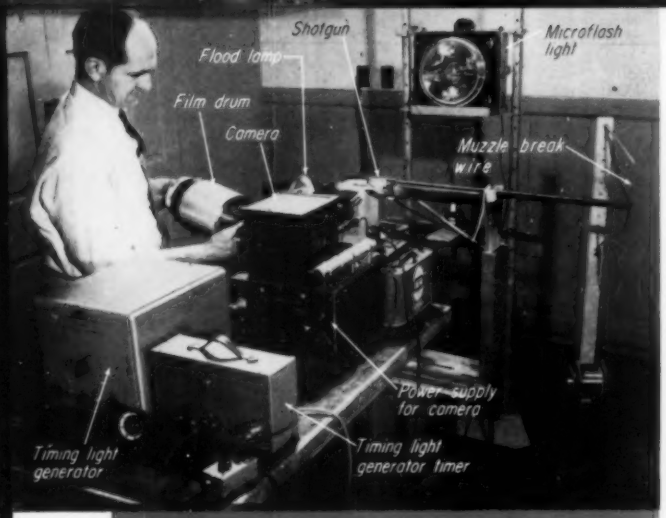
During recording, drum speed is constant and timing marks are recorded synchronously along the edge of the film record by a flashing argon light. It's actuated by a pulse generator at known frequency up to 1,000 cycles per second. High-sensitivity film is employed, such as Eastman Verichrome Pan (VP 213) with film speed rating of ASA-100. A recording paper may also

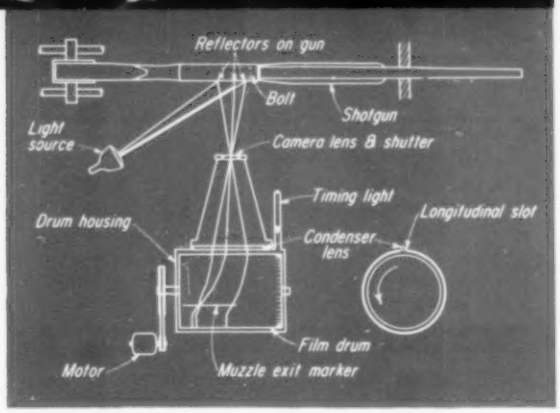


Mechanical recorder . . .
is simple, but records linear motion only.

Methods for Recording

Method	Method of Indicating Position of Moving Parts	Type of Record	Type of Motion Covered
Mechanical Drum Recorder	Mechanical scriber in direct contact with recording paper	Continuous trace on wax paper	Linear
Electrical Potentiometer Recorder	Potentiometer voltage changes with position	Continuous oscillograph record	Linear
High-speed Movie Camera	Records full images of moving part	Intermittent direct pictures	Two-dimensional
Drum Camera	Records point image of moving part	Continuous trace on film	Linear





Test setup . . .
of drum camera to record recoil action of new Winchester Model 50 Automatic Shotgun. The schematic shows light path through continually open camera lens to rotating drum.

be used, such as Dupont Lino-Writ, although the paper does not have as much sensitivity as the film.

OPERATING THE CAMERA

The operator first adjusts the camera so reflected light beams must enter through the longitudinal slot. Drum axis must be parallel to linear track of the moving parts and is brought up to a speed where slope of the recorded trace is approximately 45°. Initiation of the motion to be studied, that of an automatic shotgun, for example, must be synchronized with opening and closing of shutter. This is usually done with solenoids that pull the gun trigger, and open and close the shutter in proper sequence. Simultaneously, the timing light is actuated.

Time of recording is usually limited to one revolution, but may extend over several. The instant when bullet leaves the muzzle is recorded by a single flash from a high-speed flash lamp. The lamp is actuated by the bullet when it breaks a brittle wire at the muzzle.

ANALYZING THE RECORD

The typical T-D record sketched on next page shows traces of three moving parts: operating rod, bolt and receiver. There are two points on the receiver, 3.5 in. apart, which are painted to reflect light. This distance establishes the displacement scale or "magnification" $q = y_o/3.5$; magnification is varied by changing the distance between camera and moving parts.

Flash marks at edge of the record define the film speed, p, or time scale. For a given T-D record, both p and q are constant values, facilitating evaluation.

Reading a T-D record is quick and becomes routine after short use. A straight trace indicates uniform motion at constant velocity, with velocity proportional to slope of the trace. A gradual curve expresses slow acceleration or deceleration, such as caused by spring

Time-displacement Characteristics of Fast-Moving Parts

Attachments Required	Capacity in No. of Moving Parts	Indication of Displ. Scale (Magnifica.)	Indication of Time Scale	Speed of Evaluarion	Accuracy of Record and Evaluation	Recommended Applications
Extension rods plus scribers	Few (usually about three)	One-to-one	Mechanical vibrator (tuning fork); nearly constant scale	Very quick (No processing of record)	Fair to good, depending on weight of attachments	Simplest method; for heavy moving parts and low accelerations only.
Extension rods plus electrical sliding contacts	Few (usually about three)	Requires electrical calibration	Timing generator plus flash bulb or oscillator; usually scale is variable	Quick	Fair to good, depending on weight of attachments	For medium to heavy and inaccessible moving parts.
None (uses paint marks)	Any number	By known reference distance	Timing generator plus flash bulb; variable scale	Time-consuming and tedious	Fair	For qualitative rather than quantitative studies; 2-D motion.
Very minor (paint marks, soldered pins, machined grooves)	Many	Indicated by reference distance or special "rake"	Timing generator plus flash bulb; constant scale	Quick	Good. No falsification by heavy attachments	Simple; for any weight of moving parts. True recording of shock+vibration phenomena. Simple, accurate and economical in film.

forces or friction. A sharp corner indicates impact against another part. Such a continuous record accurately indicates details of shock and vibration not detectable by other methods. In fact, the record becomes a "cardiogram" of the mechanism.

SPEEDING THE ANALYSIS

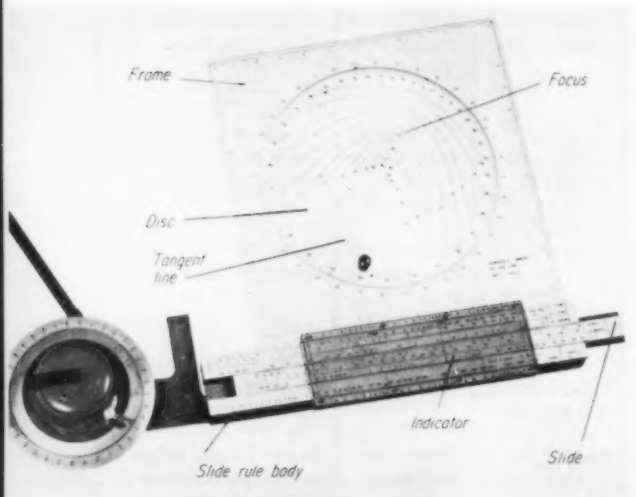
An instrument has been developed by the author at Springfield Armory to rapidly analyze T-D curves for velocity and acceleration. It consists of a measuring device and a slide rule mounted together. For easy parallel sliding, it can be mounted on a T-square.

For a given T-D record, the film speed p and magnification q are determined from the horizontal and vertical inch scales of the measuring device. To get the slope angle, the disk is rotated so that its "tangent line" is tangent to the point on the curve under study. The slide rule is adjusted by properly aligning q-scale of the slide with p-scale of the body, and aligning the indicator with value of the slope angle. Velocity and acceleration of the point can now be directly read from the appropriate scales at hairline of the indicator.

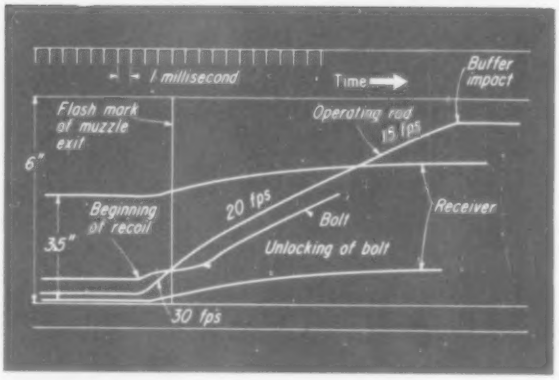
Points have to be marked but there are no lines to be drawn and all numerical computations are eliminated. Position of the slide rule is valid for the entire record—only the indicator must be moved when computing different points. Although models of this instrument are in use, it is not commercially available.

REPRINT of this article can be obtained for your reference file by checking No. E34 on one of the Reader Service cards inside back cover. For other reprints available see "Current Reprints" listing in this issue on page 133.

EDITOR'S NOTE: The drum camera was also employed by Dr. Maier to analyze dynamic behavior of helical springs under impact. See "Surge Waves in Compression Springs," Aug '57, p 167.



Velocity and acceleration . . .
of any point on T-D curve can be read off directly with this combination of templet with special slide rule.



Drum T-D record . . .
of recoil action shows traces of operation rod, bolt and receiver. Vertical scale indicates displacement; horizontal scale indicates time.

THE DRUM CAMERA'S THREE RIVALS

• **Mechanical drum recorder** . . . offers the simplest way to get T-D (time-displacement) records but is limited to analyzing heavy parts moving at low speed and acceleration. A drum of high rotary inertia and covered with wax paper is aligned with the track of the moving parts. Each part is provided with a longitudinal extension rod and spring-loaded scriber which traces a continuous curve on the paper.

Displacements are recorded in full scale; time scale is indicated by marks traced on the paper by a mechanical oscillator, such as a tuning fork—amplitude of oscillation is sustained electrically.

• **Electrical potentiometer recorder** . . . is a purely electrical method. The moving parts are fitted with extension rods and slide which continuously contact parallel wires of a Wheatstone Bridge type circuit. The motion changes the electrical resistance; corresponding voltage change is recorded on a moving film as a continuous oscillograph tracing. The film is usually run from a feed-spool to a take-up spool at variable speed, which is indicated at the edge of the record by intermittent time flashes of known constant frequency. Calibration and operation is sometimes difficult, and weight of the extension rod also influences the recording. Method is best where moving parts, fully enclosed, cannot be photographed.

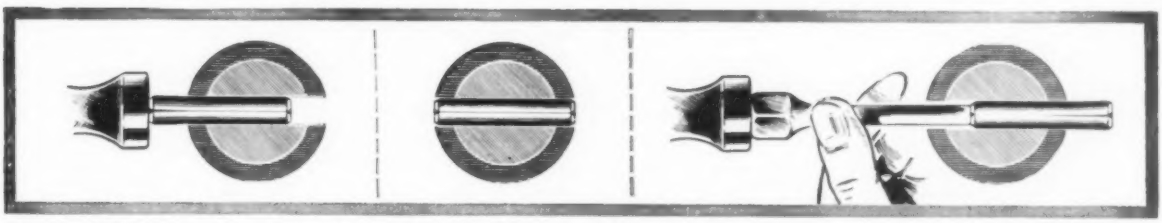
• **High-speed movie camera** . . . records movements of a mechanism at frequencies up to 7000 frames/sec for commercial 16mm cameras. No recording attachments are fixed to the moving parts. All motions parallel to optical plane of the camera lens are recorded, giving 2-dimensional coverage. Problem here is that film speed from feed spool to take-up spool increases with time, resulting in a non-uniform time scale, indicated at the edge of the record by intermittent time marks. The prints give direct, illustrative pictures of the mechanism. However, high-speed movies are time-consuming and not too accurate for quantitative-data evaluation because of small picture size, the many pictures to be evaluated, and the non-uniform time scale. This intermittent-picture method also cannot clearly show details of impact and vibration behavior.

what makes this fastener DIFFERENT?

Several things. Rollpin® is a slotted, chamfered, cylindrical spring pin which drives easily into a hole drilled to normal production standards. It locks securely in place, yet can be drifted out and reused whenever necessary. This eliminates special machining, tapping, and the need for hole reaming or precision tolerances. Rollpin replaces taper pins, straight pins and set screws; for many applications it will serve as a rivet, dowel, hinge pin, cotter pin or stop pin.

And here's another difference that makes Rollpin the quality fastener in the field: ESNA's quality control builds consistent strength and performance into every Rollpin. Rollpin is uniform as to shear strength, dimensions, hardness, and insertion and removal forces

HOW YOU INSERT IT



Drives easily by hammer, arbor press, or air cylinder and can be readily adapted to an automatic hopper feed. Requires only a standard hole, drilled to normal production-line tolerances.

Locks securely in place without using a secondary locking device; won't loosen despite impact loading, stress reversals, or severe vibration.

Removes readily with a drift pin without damage to pin or hole, can be used again and again in original hole.

HOW YOU SAVE

You pay less for Rollpins than for most tapered, notched, grooved or dowel pins. Installation costs are substantially less than for any fastener requiring a precision fit or secondary locking operations.

Because of their tubular shape, Rollpins are lighter than solid pins. Production maintenance is reduced with Rollpins: they do not loosen and because of their spring action they tend to conform to the drilled hole in which they're inserted, without material hole wear, eliminating the necessity of re-drilling or using oversize pins.

MATERIALS AND SIZES

Standard Rollpins are made from carbon steel and Type 420 corrosion resistant steel. They're also available in beryllium copper for applications requiring exceptional resistance to corrosive attack, good electrical, anti-magnetic, and non-sparking properties. Stock sizes range from .062" to .500" in carbon and stainless steels.

ROLLPIN®

ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, New Jersey Dept. R40-72

Please send me the following free fastening information:

- ☐ Rollpin Bulletin
- ☐ Elastic Stop nut Bulletin
- ☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name _____ Title _____

Firm _____

Street _____

City _____ Zone _____ State _____

15 PLATE-STIFFENINGS

Tests at Munich University show strength differences among various designs of stiffened sheet-metal plates.

FROM ABROAD

This article is a PRODUCT ENGINEERING digest of a two-part German article by K. LOWENFELD in *Der Maschinenmarkt* (Wurzburg), Nos. 87 and 98, Oct. 29 and Dec. 6, 1957.

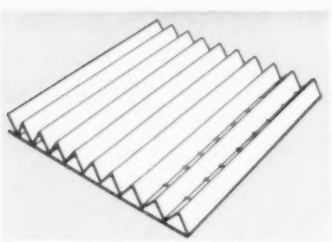
When plates of sheet metal are stiffened with channels, honeycombing, gussets and the like, the strength is increased. But how much? Researchers at Munich University found out. Their results are shown here, in comparisons of various stiffened sheets with unstiffened, flat plate.

Stiffness value of the reference plate is taken to be 1, and values for the other plates indicate how many times stiffer they are than the reference. All plates were 500 mm square (20 in.) and 3 mm (about $\frac{1}{8}$ in.) thick. Web thickness was 1 mm (about $\frac{1}{32}$ in.); height was 40 mm (about $1\frac{3}{8}$ in.) All constructions were welded.

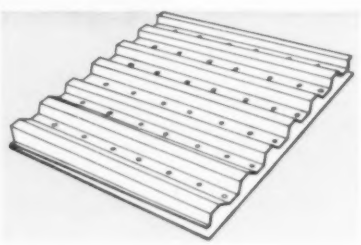
For sandwich construction the reference-plate thickness is doubled, to give a thickness of 6 mm.

LOAD	APPLICATION	PLATE NUMBER														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Torsion	Single	48	40	28	11.3	3.5	27	33	24	1.3	10.6	1.3	4.2	3.3	7.5	1.6
	Sandwich	62	29	20	8.1	29	85	44	42	48	24	4.8	18	56	21	8.7
Bending (single)	x Axis	112	58	18	47	10	10.3	12.5	22.5	16.3	8.8	1.0	1.6	27	7.5	1.2
	y Axis	1.1	1.3	30	1.2	10	10.3	12.5	7.8	16.3	8.8	1.0	9.3	6.9	65	1.2
Bending (sandwich)	x Axis	150	62	19	62	11	83	16	29	32	3.6	3.6	27	52	30	6
	y Axis	56	13	16	2.0	11	83	16	29	32	3.6	3.6	7.3	31	10	6
Strength / Weight	Single, torsion	30.7	26	17	8.1	2.1	10	18	1.5	7.3	6.8	1.0	2.6	2.1	4.1	1.1
	Single, bending	x 72	28.2	10	34.5	5.8	3.4	6.7	13	9.1	5.7	0.74	1.1	16	3.9	1.1
		y 0.75	0.8	18	0.85	5.8	3.4	6.7	4.6	9.1	5.7	0.74	5.4	4.2	34	1.1
	Sandwich, torsion	48	23	14.5	6.5	23	45	32	32	33	19	40	14	44	15	7.3
	Sandwich, bending	x 116	50	14	50	8.5	44	11	22	21	2.6	2.6	21	41	21	5
		y 43	10	12	2.3	8.5	44	11	22	21	2.6	2.6	5.6	24	7	5

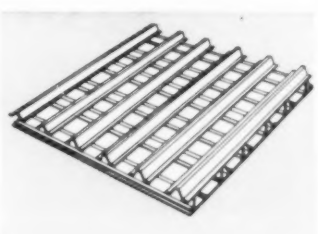
1 Angles



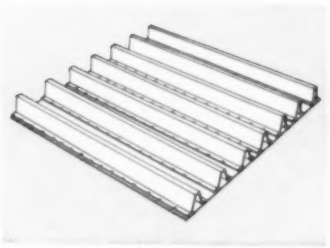
2 Corrugated plate



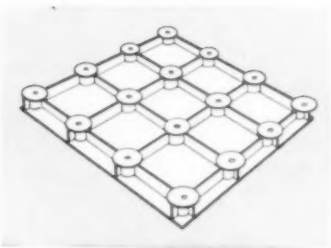
3 Two layers of single channels arranged crosswise



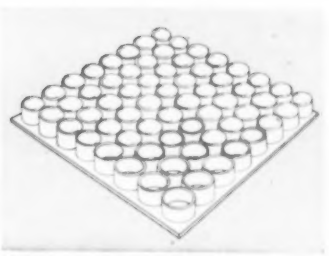
COMPARED



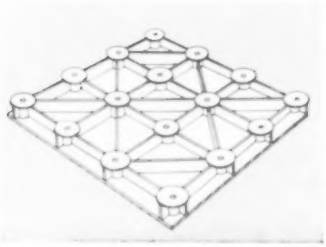
4 Single layer of channels



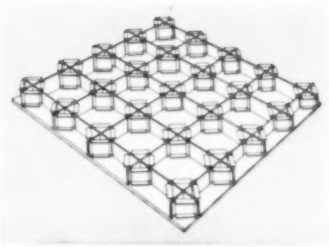
5 Round gussets and straight ribs



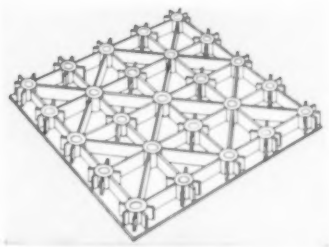
6 Tube sections welded to each other



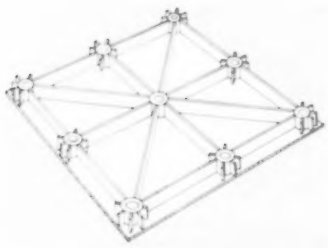
7 Round gussets, straight and diagonal ribs



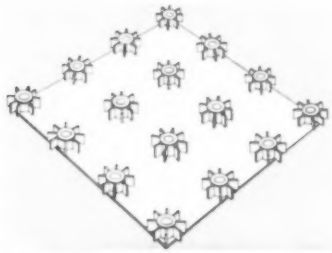
8 Round gussets made from channel sections



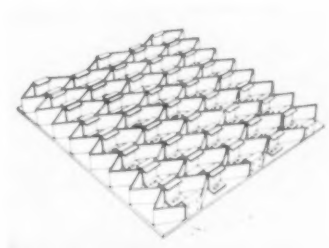
9 Starlike gussets and radial ribs (close together)



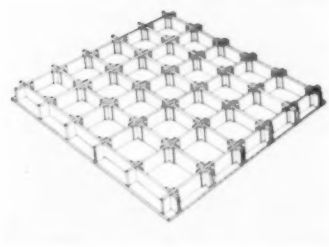
10 Starlike gussets and radial ribs (far apart)



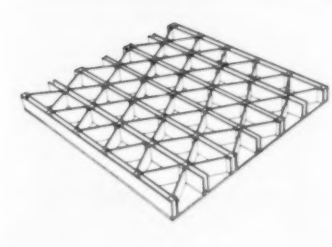
11 Starlike gussets without ribs



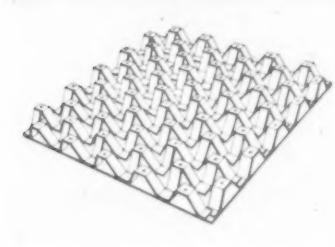
12 Honeycomb



13 Straight sheet ribs and angles



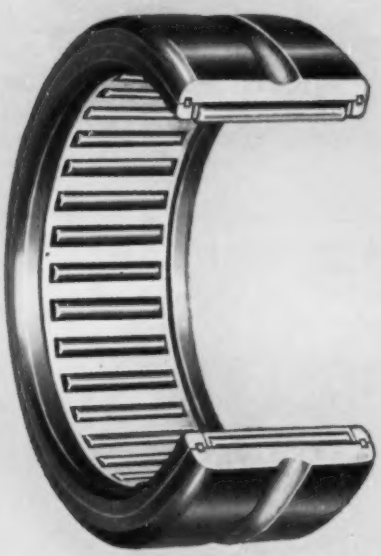
14 Studs, strips and angles



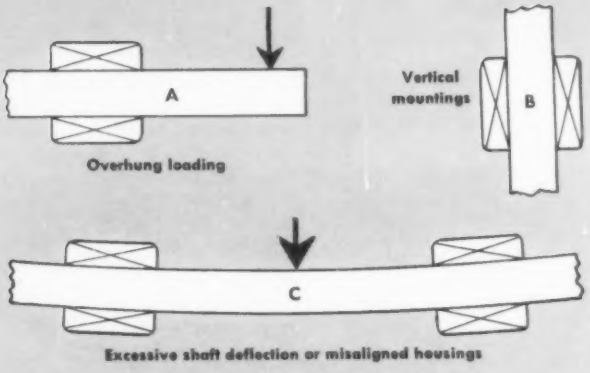
15 "Weave" pattern

ORANGE *Cage Type* NEEDLE BEARINGS

provide solution to many "problem" bearing applications

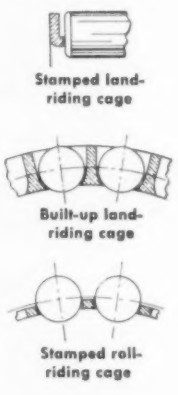


Needle bearings carry exceptionally high loads in proportion to their size. For maximum performance, many applications, as illustrated below, require an effective retaining cage when (A) loads are overhung, (B) mounting is vertical or (C) when shaft deflection or misaligned housings adversely affect operation.



How unique Orange Cage Designs prevent skewing of rolls

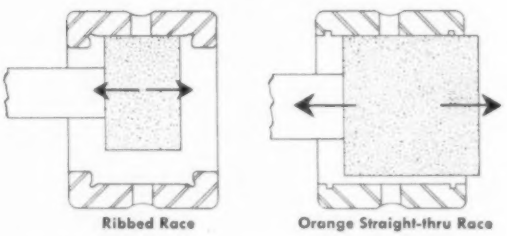
Orange cage designs, wherein the pockets are slightly narrower than the roll diameter, assure contact along the entire length of the roll periphery to resist skewing. This construction also insures positive and permanent retention of rolls.



Wide choice of Cage Designs best suited to service conditions

As the first to develop cages for needle bearings, Orange engineers have learned from long experience that no single cage construction is adaptable for all sizes of needle bearings. As a result, Orange offers cage designs in various constructions and materials to best meet the needs of each particular application, for optimum bearing performance.

Races are thru, centerless ground and air gaged for accuracy



This precision grinding assures the ultimate in roundness, concentricity, finish and freedom from taper. When grinding internal diameters, the grinding wheel should reciprocate beyond the race bore to achieve these desirable results. Upper right illustration shows how the absence of ribs on the Orange race permits unrestricted wheel movement and contact across entire surface.

Orange Cage Type Needle Bearings are available from stock, in a wide range of sizes from ½" to 8" shaft diameters.

WRITE for 40-page Engineering Reference Manual giving full specifications of Orange Cage Type Needle Bearings and other Orange Roller Bearings.

ORANGE ROLLER BEARINGS

ORANGE ROLLER BEARING CO., Inc.
551 Main Street, Orange, N. J.

Needle Bearings — Staggered Roller Bearings
Journal Roller Bearings — Thrust Roller Bearings
Cam Followers

curves find

BENDING and TORSION STRENGTH of Thin-walled Cylinders

Safety-margin formulas are also given in this followup to the author's article on compression-strength curves (July 7, p. 77).

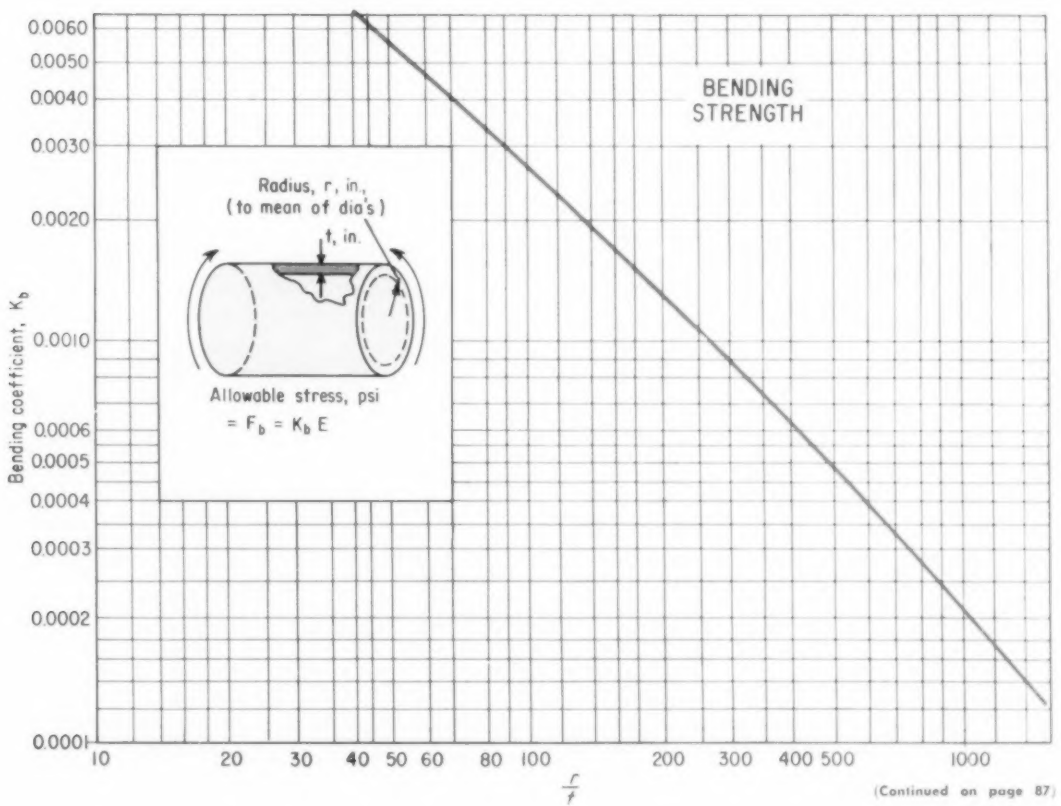
IRENE KUSMISS, *Design Engineer, Walter Kidde Co.*

The values obtained from these curves are for pure bending and torsion whereas the curves in previous article were for pure axial compression. For combined loadings no general theory exists that will apply to all cases. Empirical formulas on the next page can be used for combined loading conditions to find safety margins.

Example: Allowable compression stress for pure axial compression is 11,850 psi, allowable bending stress is 6600 psi. Actual compressive and bending stresses are, respectively, 3000 psi and 4500 psi. Safety margin for combined loading is

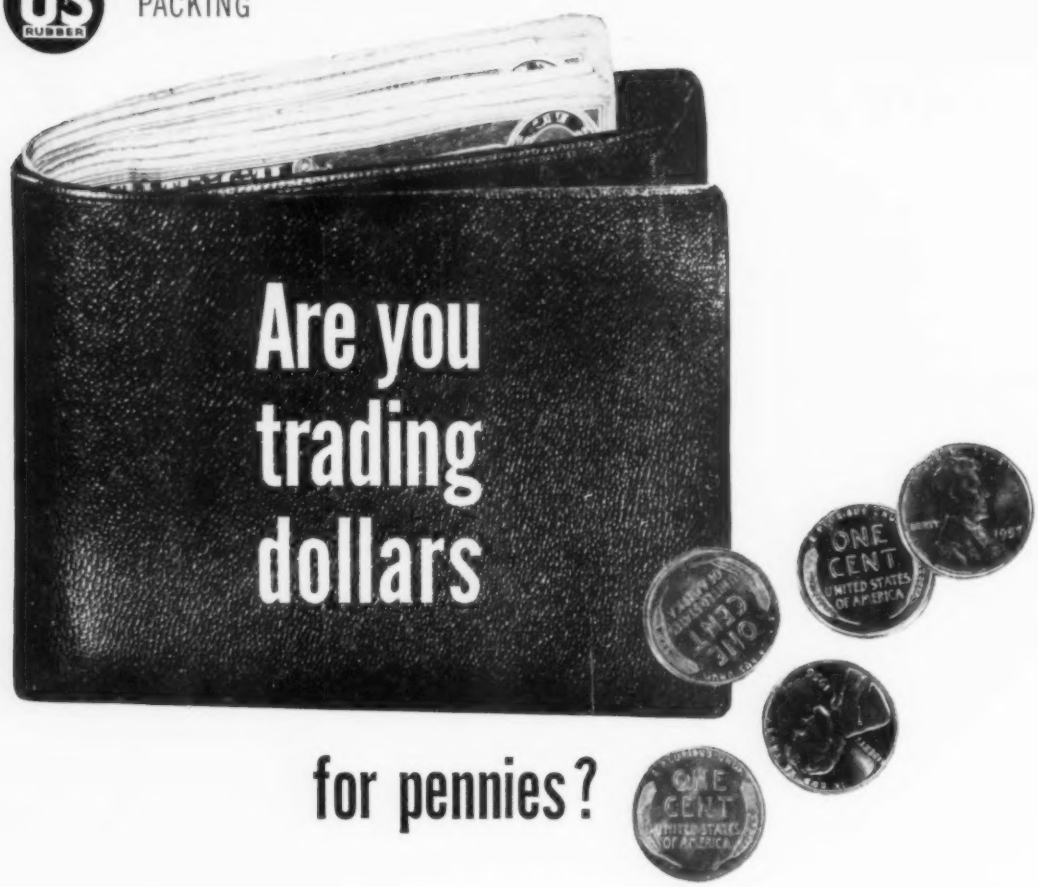
$$\frac{1}{R_c + R_b} - 1$$

Since $R_c = 3{,}000/11{,}850 = 0.253$, and $R_b = 4{,}500/6{,}600 = 0.662$, the safety margin will be 0.093.



(Continued on page 87)

US RUBBER PACKING



You may be. Consider this: How much does it cost you every time you shut down a production line to replace the packing in just one piece of hydraulic equipment? Now, multiply this by the amount of times this same equipment has had to be re-packed, say, in the past three years. And multiply this figure by the total amount of hydraulic equipment in your production system.

This downtime cost is enormous—just for packing. It's far higher than the cost of the packing itself ...and a lot more than the pennies saved by buying less expensive, inferior packing.

It's for this reason that packing like U.S. Matchless® is, by far, your most economical buy. It's made in a variety of styles, each for specific applications. Used and recommended by many of the leading original equipment manufacturers, Matchless is a packing you can trust to do the job longer, better... to turn downtime losses into uptime profits.

U.S. Matchless is part of a complete line of quality packings available at your "U.S." Distributor, or write us at Rockefeller Center, N. Y. 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

U. S. MATCHLESS PACKING

US RUBBER Mechanical Goods Division

United States Rubber

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BENDING and TORSION STRENGTH (continued)

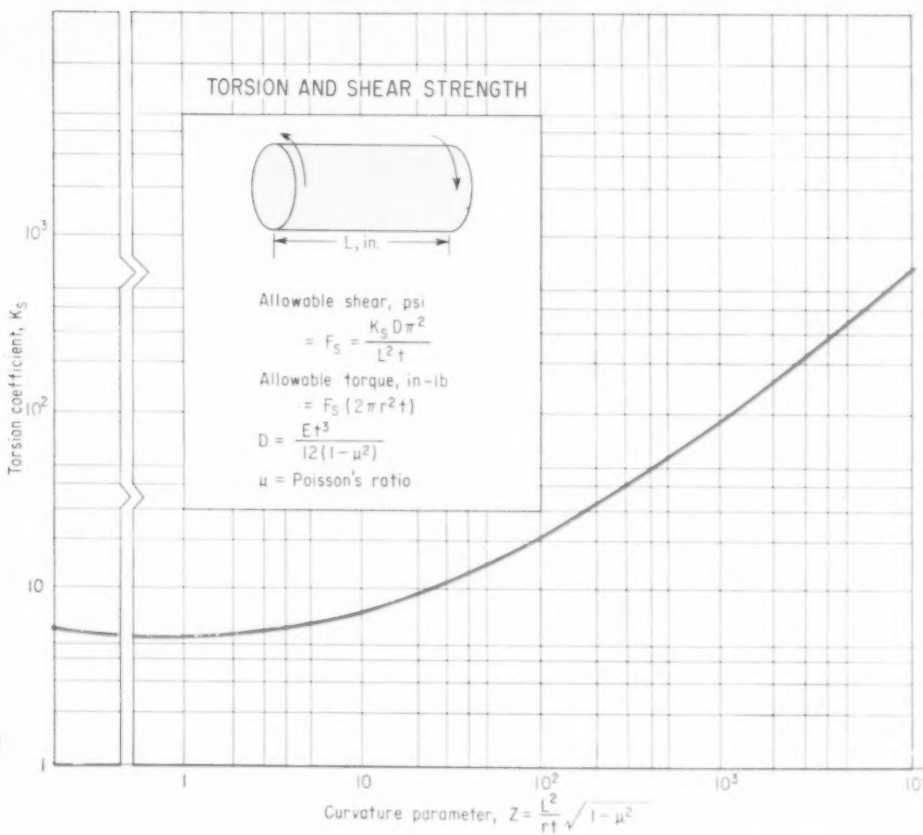
SAFETY MARGIN FORMULAS

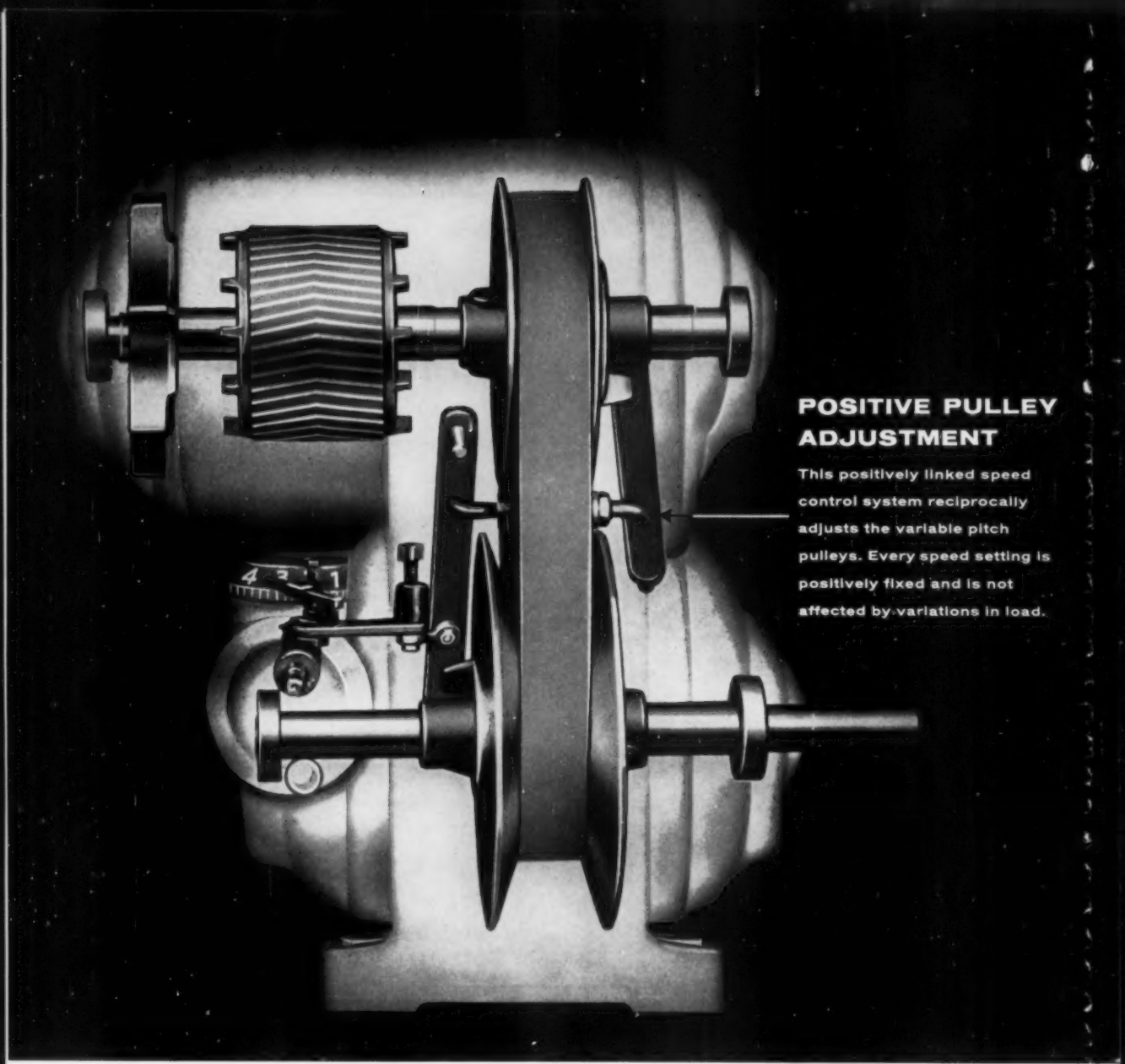
TYPE OF LOADING	SAFETY MARGIN
Compression (axial)	$\frac{1}{R_c} - 1$
Bending	$\frac{1}{R_b} - 1$
Transverse shear (from torque loads)	$\frac{1}{R_s} - 1$
Compression and bending	$\frac{1}{R_c + R_b} - 1$
Compression and transverse shear	$\frac{2}{R_c + \sqrt{R_c^2 + 4R_s^2}} - 1$
Bending and transverse shear (occurring 90° apart)	$\frac{1}{\sqrt{R_b^2 + R_s^2}} - 1$
Compression, bending and shear	$\frac{2}{R_c + R_b + \sqrt{(R_c + R_b)^2 + 4R_s^2}} - 1$

$R_c = \frac{f_c}{F_c}$ = ratio of actual to allowable compressive stresses

$R_b = \frac{f_b}{F_b}$ = ratio of actual to allowable bending stresses

$R_s = \frac{f_s}{F_s}$ = ratio of actual to allowable shear stresses




POSITIVE PULLEY ADJUSTMENT
This positively linked speed control system reciprocally adjusts the variable pitch pulleys. Every speed setting is positively fixed and is not affected by variations in load.

New Worthington motor drive gives you

ACCURATE SPEED REGARDLESS OF LOAD

Once you set the speed on a Worthington variable speed motor drive, the pulley holds it – maintaining accurate speed control regardless of variations in load.

This unique feature is the result of "positive pulley adjustment." A positively-linked speed control system reciprocally adjusts the variable pitch pulleys. Unlike spring-equipped drives which constantly maintain maximum belt tension to meet occasional peak loads, belt tensions in a Worthington drive never exceed the actual load transmitted. Peak and momentary starting loads are transmitted just as smoothly as they would be with a standard fixed speed V-belt drive.

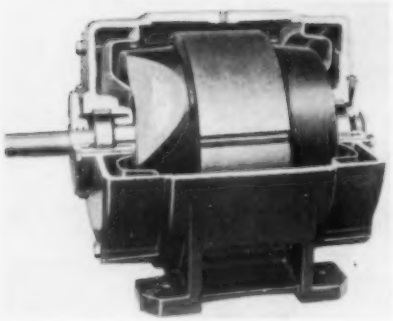
Positive pulley adjustment also results in a compact design with inherently long belt life. The wide-angle design of the belt offers deep side walls for greater contact area. This feature gives you high power capacity with minimum belt pressure. The large diameter pulleys assure smooth, efficient operation with little wear.

The new line is available in speed variations up to 10:1 and horsepower ratings from ½ to 25 hp. You can specify finger tip speed control or one of the many types of remote controls – both automatic and mechanical. For complete information, write for Bulletin 1610-B1. Address Section MV-78, Worthington Corporation, Oil City, Pa.

WORTHINGTON

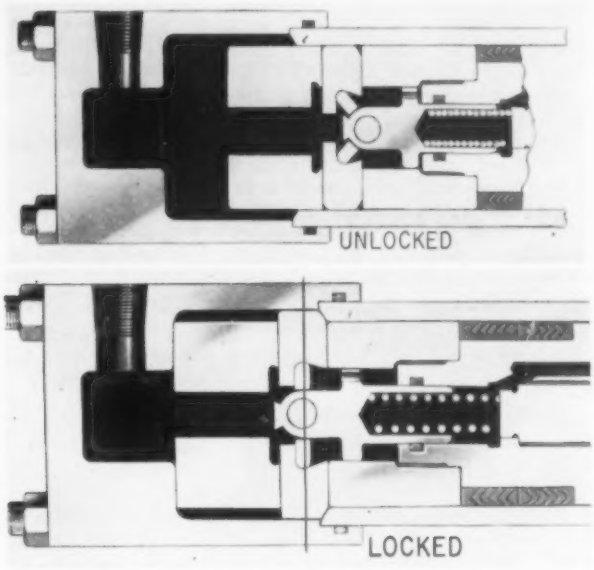
CIRCLE 147 READER SERVICE CARD

NEW COMPONENTS and MATERIALS



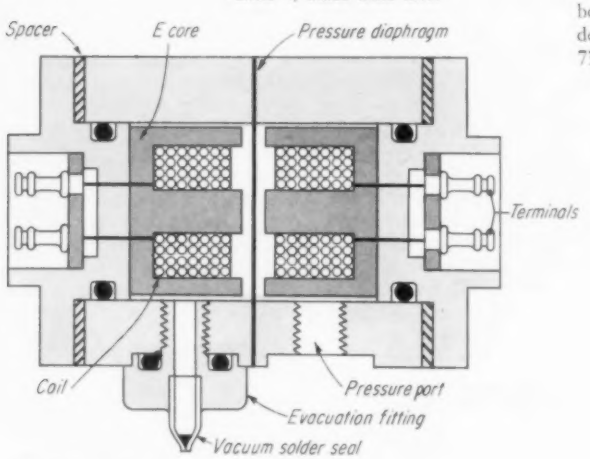
Encapsulated motor stator . . .
is cast in an epoxy resin, and can be used where moisture or contaminated atmospheres could destroy effectiveness of conventional insulation, previously protected by special enclosures. Epoxy resin is also cast throughout slot portions. Conductor, phase and slot insulation may be of Class A, B or H materials. Epoxy now in use is for Class B temperatures. Offered in all integral hp frame sizes in which random-wound coils are used. About 10% higher in price than standard Class A, insulated, open-type motors. Delivery, 4 to 8 wk. **Allis-Chalmers Mfg. Co., Milwaukee 1.**

Circle 1, inside back cover



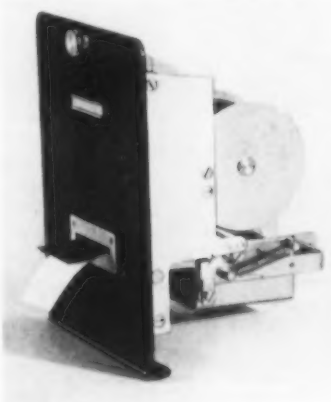
Toggle in hydraulic cylinder locks . . .
machine element under heavy loads in extended, retracted or either position, so that system need not be kept pressurized when not in use. Normal operating forces are sufficient to unlock butterfly-type toggle. Cylinders are available in 2, 2½ and 3-in. bores, any stroke, to 1500-psi operating pressure. About $127, depending on size and stroke. From stock. **Tog-Loc, P. O. Box 735, Bellevue, Wash.**

Circle 2, inside back cover



Adjustable pressure transducer . . .
is of double-coil variable-reluctance type and has a flat diaphragm as pressure sensing element. Translates gas or liquid pressure to proportional electrical signals suitable for recording or control systems. Pressure-sensitivity adjustments are accomplished with spacers which vary air gap between E-cores and diaphragm. Transducers of one range are interchangeable with those of any other. Output is 0.3 v per volt over a carrier frequency range from 400 cps to 70 kc. Instrument is ⅝ x 1⅜ in. long. Weighs less than 2½ oz. Delivery on standard models, 6 to 8 wk. Differential and gage types are $315 each; absolute model is $345. **Yuba Research and Development Center, 675 E. H St., Benica, Calif.**

Circle 3, inside back cover



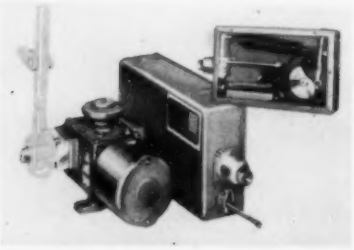
Electrical printing counter . . .
is available in a number of variations with up to four 5-digit counting heads printing on one tape that perforates as it issues from front of instrument. Counting speed is 25 per sec; printing time, $\frac{1}{10}$th sec; reset time (optional), ½ sec. For 24 and 60 v dc only. Face dimensions are 3 $\frac{9}{16}$ x 5 $\frac{13}{32}$ in. Basic counting head is $40; typical unit with one counting head and a reset motor is $240. 8-wk delivery. **Presin Co., 12128 W. Pico Blvd., Los Angeles 64.**

Circle 4, inside back cover

. . . CONTINUED ON PAGE 90

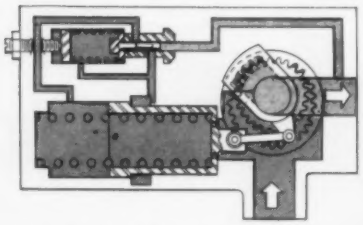
Analog-to-digital converter . . . is said to provide 10-bit resolution with a 3½-in. disk. Yields up to 1024 position reports, permitting for example, control of linear machine feeds to within 0.001 in. of travel. Although essentially a shaft converter of analog signals to binary digital information, modification with auxiliary self-balancing potentiometers, or servo combinations, permits application to a variety of positional movements in three-dimensional parameters, and to follow fluctuations in fluid flows and temperatures. Priced under $500. Delivery in 60-90 days. **Librascope, 808 Western Ave., Glendale, Calif.**

Circle 5, inside back cover



Electrically controls pressure . . . or temperature by a simple sensing mechanism coupled with heavy-duty drive motor. Drive motor can be stalled indefinitely and continuously reversed. Unit has wide adjustment range. Regulator shown has torque range to 204 in.-lb and pressure range to 600 lb. Others available with torque to 12,000 in.-lb. Has integral cast iron motor housing and gear case, heavy-duty enclosure, dust-tight construction. **Optimum Control Corp., 2930 Woodhill Rd., Cleveland 4.**

Circle 6, inside back cover



Variable-displacement pumps . . . consist mainly of an internal ring gear and pinion. Integral pressure-sensing device automatically compensates pressure, adjusting pump displacement to meet variations in system delivery requirements. Can be set for manual or automatic remote control. Gear set alignment is maintained independent of hydraulic loads or thermal conditions. Available for operation at speeds to 24,000 rpm, temperatures to 500 F, deliveries up to 80 gpm, and pressures up to 3000 psi. Pump is for low tooth contact loads, smooth transfer of driving forces, quiet operation, low approach and sliding velocities. Gear-tooth form is designed with a low clearance volume; as teeth disengage, space increases gradually, creating a vacuum into which inlet hydraulic fluid flows at low velocities. Designed primarily for high-speed, elevated-temperature hydraulic systems, but lightweight models are also offered. **Pesco Products Div., Borg-Warner Corp., Bedford, Ohio.**

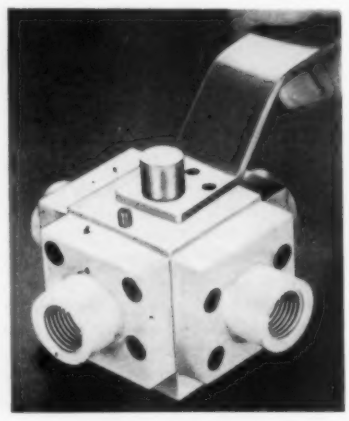
Circle 7, inside back cover

High-temperature alloy . . . for applications to about 500 F is available in sheet, plate, extrusions, hand or die forgings and forging stock. Principal alloying elements are copper, magnesium, iron and nickel. At room temperature, alloy in T61 temper has typical ultimate tensile strength of 64,000 psi and yield of 54,000 psi. After 10,000 hr of exposure at temperatures over 300 F, alloy retains ultimate strength of 50,000 psi and yield of 45,000 psi. After similar exposure at 400 F, typical properties are 33,000 psi ultimate and 30,000 psi yield. **Kaiser Aluminum & Chemical Sales, Inc., 919 N. Michigan Ave., Chicago 11.**

Circle 8, inside back cover

Directional control valve . . . for hydraulic systems of 0 to 3000 psi. Valve will handle hydraulic oils, non-corrosive fluids, lubricated air. Has high flow capacity with low pressure drop and minute internal leakage, if any. Valving of fluids requires low turning torque, even under high operating pressures. Four-way unit has an open or closed center, aluminum body and hardened steel operating parts. Metal-to-metal seals are both spring- and pressure-loaded for positive sealing. Valve rotor is pressure-compensated to reduce turning torque. Valve is available with either ¼, ⅜ or ½-in. dry-seal pipe thread ports and made-to-order special porting at no additional cost. Can be operated at full rated pressure by applying 49 in.-lb or 7 lb torque on the end of 7-in. handle. Each port is attached individually to the body and may be selected, changed or serviced without special tools. **Sarasota Precision Products, Inc., 1314 Lime Ave., Sarasota, Fla.**

Circle 9, inside back cover



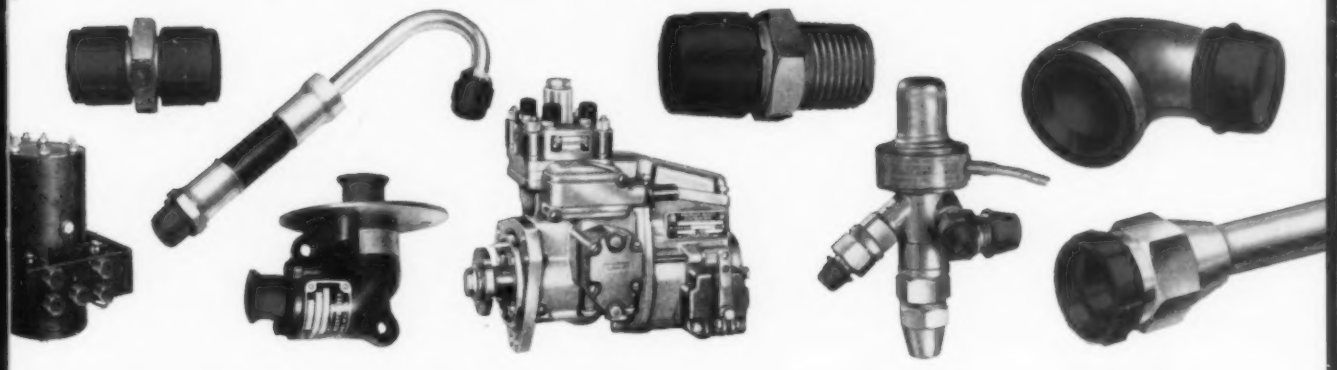
Coiled nylon air hose . . . for use with pneumatic tools is heat resistant and unaffected by oil, kerosene, gasoline. Hose withstands high operation pressures and is abrasion and chemical resistant. Recoil characteristics in combination with a portable attachment provides unlimited flexibility and mobility of position and keeps it out of way of work. Offered in ⅜ and ¼-in.-ID sizes in a standard 25-ft length with flare fittings on each end. Shorter lengths may be cut and flared with a standard copper flaring tool. **Nycoil Co., Westfield, N. J.**

Circle 10, inside back cover

Remote control valve . . . is said to be fast for its ⅛-in. aperture. A momentary touch releases air at one side of valve piston, shifting piston to that side, opening one port and closing other. There

. . . CONTINUED ON PAGE 92

Caplugs protect nearly everything under the sun...in process, storage and transit...



prevent damage to threads and delicate parts...keep out dirt and moisture...

made of tough, flexible polyethylene...won't chip, break, shred or collapse

Caplugs

10 standardized styles... over 500 sizes in stock

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of Caplugs in exchange
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CAPLUGS DIVISION, Protective Closures Co., Inc.
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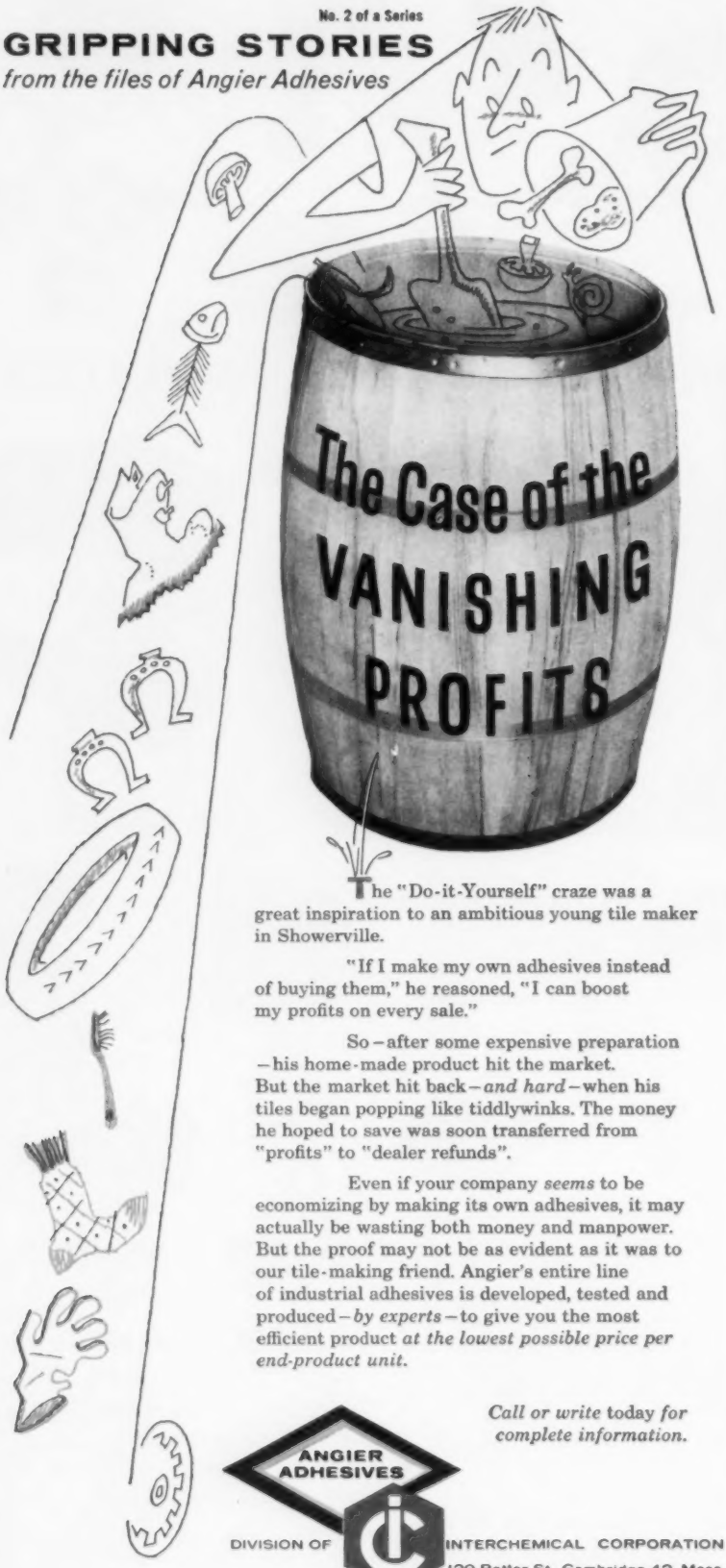
No. 2 of a Series

GRIPPING STORIES

from the files of Angier Adhesives



The "Do-it-Yourself" craze was a great inspiration to an ambitious young tile maker in Showerville.

"If I make my own adhesives instead of buying them," he reasoned, "I can boost my profits on every sale."

So—after some expensive preparation—his home-made product hit the market. But the market hit back—*and hard*—when his tiles began popping like tiddlywinks. The money he hoped to save was soon transferred from "profits" to "dealer refunds".

Even if your company *seems* to be economizing by making its own adhesives, it may actually be wasting both money and manpower. But the proof may not be as evident as it was to our tile-making friend. Angier's entire line of industrial adhesives is developed, tested and produced—*by experts*—to give you the most efficient product *at the lowest possible price per end-product unit.*

Call or write today *for complete information.*

ANGIER ADHESIVES

DIVISION OF INTERCHEMICAL CORPORATION

120 Potter St. Cambridge 42, Mass.

Midwestern Plant: HUNTINGTON, IND.

is no neutral position. Remote control is achieved by connecting miniature limit valves through ¼-in. plastic hose to be tripped by a working machine, tool, operator's finger, pneumatic timer. It can be placed at some distance from the main valve, which can be mounted in a tight corner or inaccessible spot. Valve bodies are die-cast; fittings are brass; replaceable wear plate is hardened noncorrosive metal. **Mead Specialties Co., Dept. MV-44, 4114 N. Knox Ave., Chicago, 41.**

Circle 11, inside back cover

Low-temp primary battery . . .

operates at —100 F, offering a terminal potential approximating 2.3 v. High point of temperature range is 200 F. The non-aqueous cell employs calcium for negative plate, silver chloride for positive plate and an electrolyte with an aectonitrile solvent. Unit is hermetically sealed and has no chemical reaction. Therefore, it is expected that shelf life will be infinite. **Yardney Electric Corp., 40-50 Leonard St., NYC.**

Circle 12, inside back cover

Emergency 3-circuit switches . . .

include rotary-arm-actuated and plunger-actuated models originally designed for airborne emergency devices. High-pressure springs and self-cleaning action are said to insure operation even after long dormancy (in one test, 2 yr, including 30 days at 95% humidity and 100-hr salt spray). Ratings: 400 v, 150 w, 5 amp for rotary; 28 v, 300 w, 5 amp dc-10 amp ac for plunger. **Airtron, Inc., 1096 W. Elizabeth Ave., Linden, N. J.**

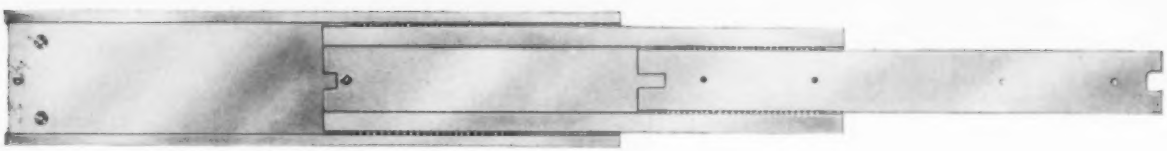
Circle 13, inside back cover

Check valve . . .

permits reverse flow when poppet is lifted from its seat. Makes certain a double-acting cylinder remains in a selected position until reverse movement is desired. Used on boom and lever installations to prevent cylinder creep. Pilot lifts poppet under back pressure with application of 30% min line pressure to pilot port. Theoretical pressure ratio between pilot piston and

(Continued on page 96)

GRANT'S MARK II THINSLIDE



Yes, you asked for it. Design engineers throughout the nation asked for it . . . a continuous ball bearing action slide to fit standard cabinets, without cabinet modification!

THE MARK II THINSLIDE. Of extruded aluminum, only ½" in overall width . . . whose inner and intermediate members pass smoothly through the space between sliding unit and standard rack. With stainless steel balls, accurately fitted to members, the Mark II is quietly, quickly extended fully from rack . . . exposing all parts immediately and with almost no effort!

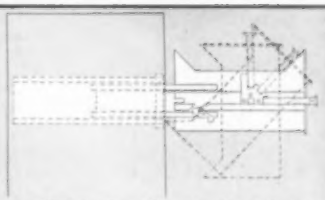
WRITE NOW FOR COMPLETE DATA ON THE MARK II THINSLIDE . . . the slide that you've been waiting for!

IF THE QUESTION IS ACCESSIBILITY . . . THE ANSWER IS GRANT.

GRANT

PULLEY & HARDWARE CORPORATION

47 High Street, West Nyack, New York • 944 Long Beach Avenue, Los Angeles 21, California



The MARK II offers tilt and locking devices as well . . . your unit can be pivoted to plus 45 and 90 degree positions for greatest accessibility. And you'll be amazed at the moderate cost of the Mark II . . . how quickly it will pay for itself **by allowing your equipment to be serviced and maintained in jig-time instead of down-time!**

See the Grant exhibit at the WESCON Show-Booth No. 132

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. . . plastics parts molded by Consolidated, that is. In every part of the globe — from Scranton, Pennsylvania to Sidney, Australia — people are using and enjoying products made more dependable by components from Consolidated. Now, with two plants working for you in Scranton, Pennsylvania, and one in Binghamton, New York, we are better prepared than at any other time in our 80 year history to take care of your requirements.

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Small Motor... BIG Idea

FOR YOUR MOTOR-DRIVEN PRODUCT

This motor is representative of the many Lamb Electric motors *specially engineered* to provide:

(1) the dependable power and smooth, efficient operation required for top product *performance.*

(2) the low weight and compactness required for easy portability and good product *appearance.*

These advantages are standard with Lamb Electric Motors, at no increase in cost, because our plant is equipped and organized to *custom manufacture on a volume basis.* May we demonstrate?

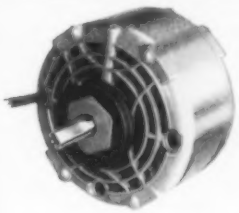
THE LAMB ELECTRIC COMPANY • KENT, OHIO

A Division of American Machine and Metals, Inc.

In Canada: Lamb Electric — Division of Sangamo Company Ltd. — Leaside, Ontario

Army tank ventilating blower motor.

Motor parts for portable electric tools.



Motor for air conditioning applications.

Motor for de-icer metering pump.

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

If you are interested in any of the above motors write and we shall be glad to send full information.

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FIREROD®

CARTRIDGE HEATING UNIT

5 to 10 times the life of conventional units

A new concept in design and manufacturing techniques has produced the FIREROD — capable of rendering 5 to 10 times the life of standard units, thus eliminating costly delays caused by burnouts. Because the FIREROD has the ability to operate at very high watts densities and temperatures, operation at normal watts densities and temperatures gives a greatly extended life and reduces your cost of operation.

More resistant to physical damage

The rugged FIREROD is better able to withstand rough handling, shock and other field conditions (such as over-voltage surges) without the breakdowns encountered in ordinary units.

Watt for watt, the long lasting FIREROD offers you maximum value for your heating dollar.

WRITE FOR **FIREROD** BULLETIN 365

WATLOW

ELECTRIC MANUFACTURING CO.
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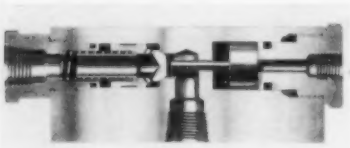
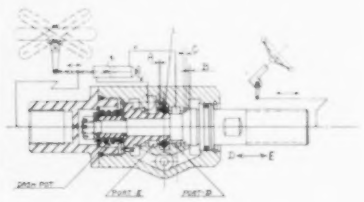
Saint Louis 14, Missouri



check valve poppet setting is 4:1. For 3000-psi hydraulic service, temperatures from —65 to 250 F. Standard in aluminum alloy, with stainless steel trim, in $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$-in. sizes or 6, 8, 10 and 12 tube sizes. **Republic Mfg. Co., 15655 Brookpark Rd., Cleveland 35.**

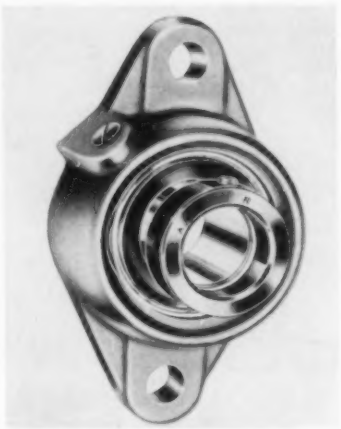
Circle 14, inside back cover



Hydraulic steering valve . . .

is located on a drag link between steering gear and steering arm. It is also connected to power cylinder that actuates steering rod. Valve has only one moving part and employs a groove-type pilot flow system to ease operation. Said to do away with oversteering, eliminating need to lap, hone and grind components to make a leakproof valve. Also overcomes excessive pressure-buildup when steering at a virtual standstill, as in parking. Suitable for trucks, lift trucks and other heavy equipment. **New Products Corp., Skokie, Ill.**

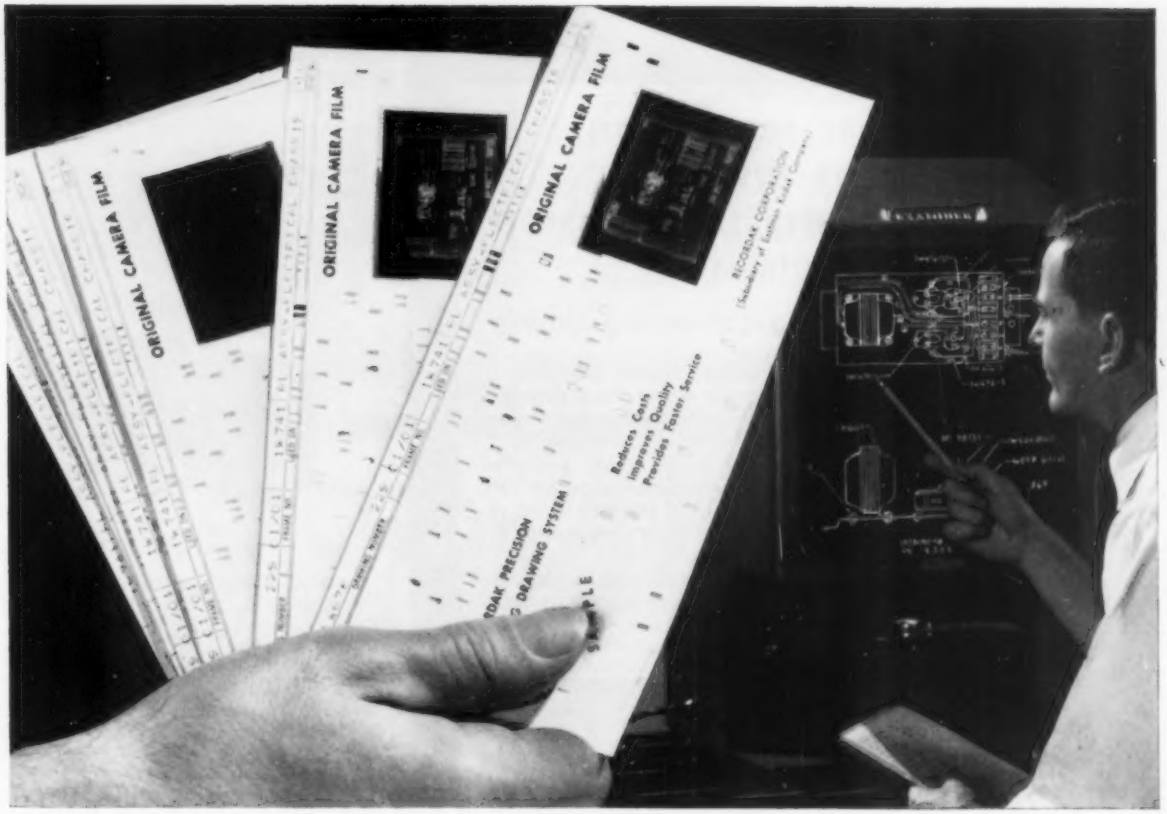
Circle 15, inside back cover



Flange ball bearing mount . . .

has two bolts instead of the standard four. Inner ring of ball bearing is self-aligning in any position and accommodates shaft dia from $\frac{1}{2}$ to $1\frac{15}{16}$ in. Bolt spacing is dimensionally same as diagonal distance

(Continued on page 98)



Decks of cards replace acres of files

New Recordak Engineering drawing system simplifies filing, reference, printmaking and print distribution . . . seems destined to change drafting-room procedures the world over.

An exclusive Recordak development. New microfilming techniques and quality-control methods perfected by Recordak give results never before achieved in 35mm microfilming. These pictures are of such outstanding quality they increase the scope of Filmsort aperture cards . . . supplant use of bulky blueprints and drawings in many drafting-room routines.

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Pitch 1/4" Width 1/8"

No. 35 Actual Size
Pitch 3/8" Width 3/16"

No. 41 Actual Size
Pitch 1/2" Width 1/4"

No. 40 Actual Size
Pitch 1/2" Width 5/16"

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Acme Chains are efficient, economical and positive for power transmission. They are readily adaptable to any drive when maximum efficiency is essential. Correct principles of design provide operating characteristics superior to any other method of power transmission. Replacement parts always readily available from stock.

Your inquiry will place a skilled Acme engineer at work on your power transmission problems.

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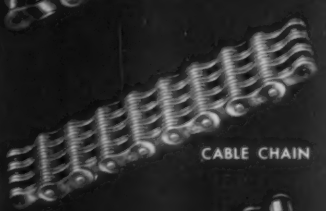
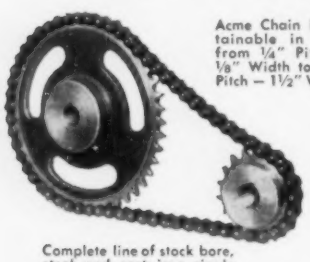
STANDARD and
OVERSIZE
ROLLERS



CABLE CHAIN

ROLLER CHAIN
SINGLE and MULTIPLE STRAND



Acme Chain is obtainable in sizes from 1/4" Pitch — 1/8" Width to 2 1/2" Pitch — 1 1/2" Width.

Complete line of stock bore, steel and cast iron single sprockets, cast iron hub sprockets and all steel split or solid hub sprockets available.

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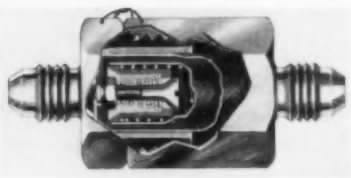
between bolt holes in standard 4-bolt type. Cast iron mount is assembled, ready for installation. Available with integral seals or contact-type seals. The latter, for slow to moderate speeds, gives extra protection against contaminants. Both are prelubricated at factory. **Fafnir Bearing Co., New Britain, Conn.**

Circle 16, inside back cover

Subminiature switch . . .

available in two shapes in a range of operating forces from 2 to 20 oz. A round-base style is particularly adaptable to ganging, for multiple switching in confined areas. Case is diallyl phthalate. Terminals are molded into the plastic cover and cannot wobble or be loosened under rough usage. Special versions, such as high-temperature model that withstands 400 F continuously, can be furnished. **Haydon Switch, Inc., Waterbury 20, Conn.**

Circe 17, inside back cover



45-micron high-temp filter . . .

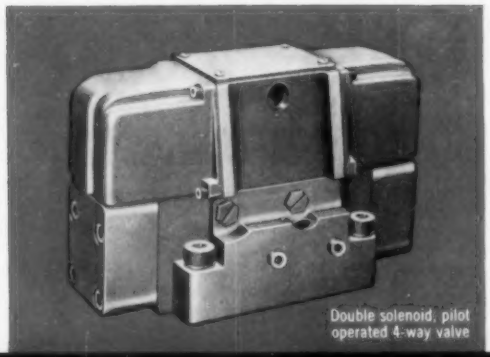
is for 1000 psi; can be designed for pressures to 4000 psi. All components are suitable for ambient temperatures from —65 to 350 F; —65 to 250 F fuel; can be designed for temperatures to 700 F. Weighs 0.17 lb in aluminum; 0.42 lb in stainless steel. Now in production. **Aero Suppply Mfg. Co., Inc., Corry, Penna.**

Circle 18, inside back cover

Linear polyethylene sheets . . .

are 0.010 to 0.150 in. thick; rolls are up to 0.04 in. thick and up to 40 in. wide, cut to individual requirements. Material withstands prolonged and repeated exposures to live steam under pressure, without becoming brittle. High crystallinity results in unusual density, high softening temperature, high tensile strength. With low permeability and limited elongation at

(Continued on page 100)



Double solenoid, pilot operated 4-way valve

Double A

Get a custom-built hydraulic circuit without custom priced valves, by using Double A, the most extensive line available. Double A has the widest selection of standard-specification valves anywhere, with almost a third again as many from which to choose. They are made for pressures up to 5000 psi, and are supplied with sub-plate (J.I.C.) mountings, flanges, or threaded connections. If there's a standard hydraulic valve made that fits your requirements, it's more than likely marked "Double A". Write for the Double A catalog.

Now, these famous hydraulic

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Gerotor hydraulic pumps easily claim superiority as the most rugged, most efficient, most dependable pumps available. They last longer, especially with low-lubricity, non-flammable fluids. This is because of their unique Gerotor mechanism. Both Gerotor elements revolve in the same direction, at low relative speed (only one revolution at point of contact for every seven to nine shaft revolutions). Delivery from .42 to 43 gpm, pressures to 2000 psi.

Model QDH, base mounted 2000 psi, 12 gpm pump

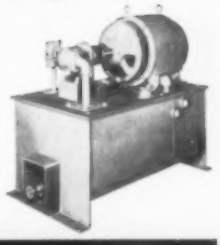
valves, pumps & power units

No. 557, herringbone geared 37.6 gpm hydraulic pump

Brown & Sharpe

Brown & Sharpe pumps, for handling machine-tool coolant, lubrication oils, and hydraulic fluids, have through the years become industry's standard line.

Double A hydraulic power units are completely pre-engineered. Don't worry about specifying or assembling components. Just select the standard unit that delivers what you require.



all come from:

Hydraulic equipment buyers everywhere will benefit from the exciting changes at Double A. Now a subsidiary of Brown & Sharpe, world renowned for the manufacture of precision machines and tools, Double A is producing Gerotor pumps and motors, and a new line of standard hydraulic power units, as well as the familiar Double A valves. For more information, write: Double A Products Co., Manchester, Mich.

For precision hydraulic components and assemblies it's

Double A

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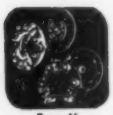

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Oil or Dry Multiple Disc

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Light Over Center

Power Take-Offs

Speed Reducers

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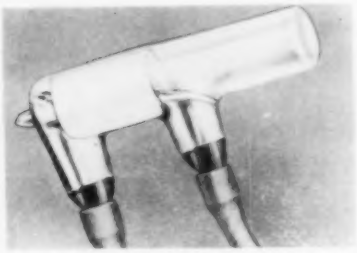
CLUTCHES

high rates of pull, as well as being nontoxic and stable, it lends itself to packaging applications, housewares, containers and can be adapted to vacuum-forming technique. Sheet stock has good gloss and comes in a range of colors. **Midwest Plastic Products Co., 1801 Chicago Rd., Chicago Heights, Ill.**

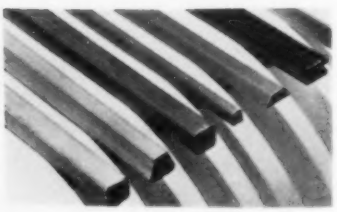
Circle 19, inside back cover



Mercury switch for 100 amp . . .

at 115 v (70 amp at 230 v) is from W. Germany and is fully compensated to accommodate large in-rush overload that accompanies initial actuation. High capacity is said to make use of this switch possible for direct control of motors and generators. Serving life is reported to be in excess of 1 million contacts. **American Designed Components, Inc., Jericho, Long Island, N. Y.**

Circle 20, inside back cover



Reinforced silicone rod . . .

is available in various extruded shapes, with continuous, integral glass fibers. Available in a range of sizes typical of initial application (insulation for transformers and generators). Said to be priced at about half the cost of competitive materials now on the market. **Pittsburgh Electrical Insulation Co., Inc., 3000 Bigelow Blvd., Pittsburgh.**

Circle 21, inside back cover

Torque-sensitive coupling . . .

shuts off power at the instant of dangerous overload. Especially advantageous where power is transmitted through two in-line shafts and torque limitation is necessary. Offered in two sizes, one of which can be set for cut-out torque from 15 to 215 in.-lb; the other for cut-out torque from 130 to 2600 in.-lb. Accommodates slight par-

(Continued on page 102)

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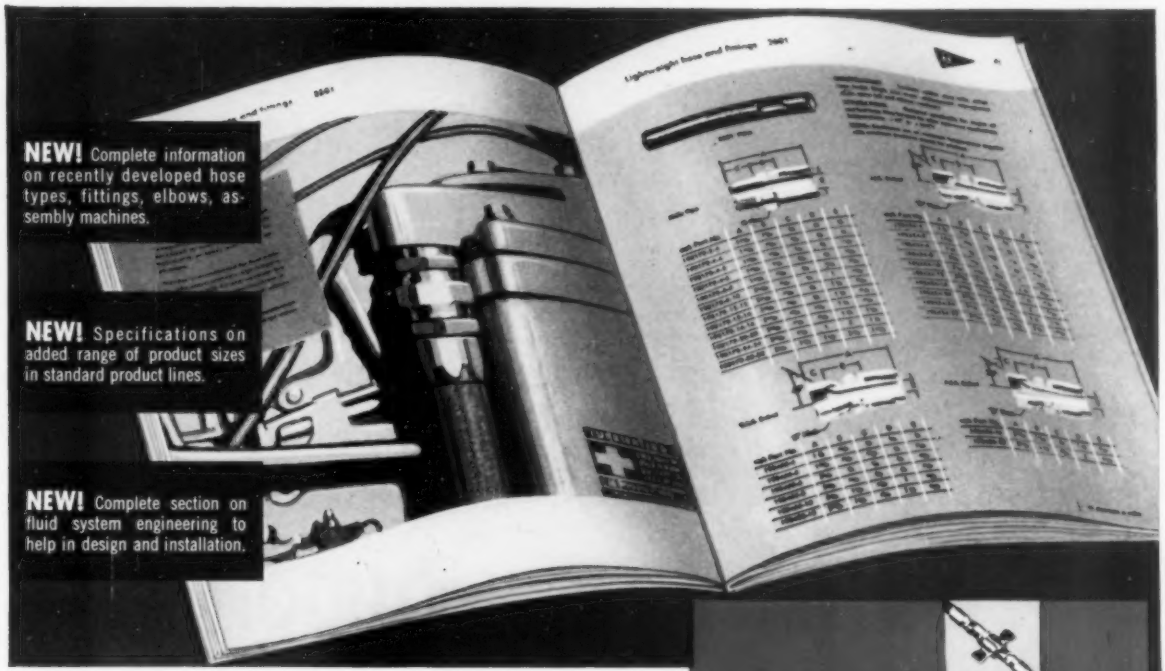
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Output Speeds: 90 to 420 RPM
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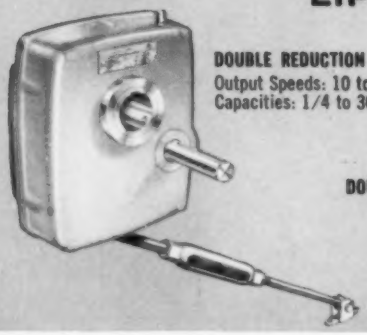
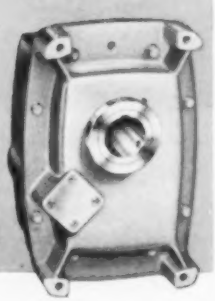


DOUBLE REDUCTION
Output Speeds: 10 to 160 RPM
Capacities: 1/4 to 30 HP

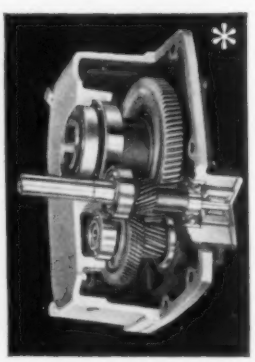


DOUBLE REDUCTION FLANGE MOUNT
Output Speeds: 10 to 135 RPM
Capacities: 1 to 7 HP

Foote Bros. Shaft Mounted Drives offer more efficient, more economical, power transmission. They incorporate exclusive *Duti-Rated* Lifetime Gearing — the high hardness, balanced design, premium quality gearing that combines greater load carrying capacity with long service life.

Used with standard V-Belts and Sheaves, Foote Bros. Shaft Mounted Drives will provide virtually any output speed you may require. Quick, easy installation on driven shafts with diameters from 15/16" to 3-7/16" saves time, labor . . . eliminates need for reducer mounting, couplings, and adjustable motor mount. Built-in Backstop to prevent reverse rotation, Automatic Overload Release Torque Arm, Variable Pulley, are available as optional equipment.

The complete Foote Bros. Shaft Mounted Drive line is made in accordance with all applicable AGMA Standards.



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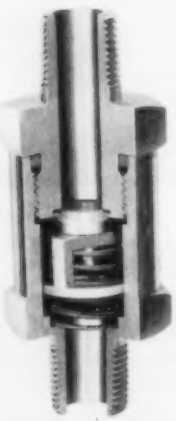
allel misalignment, angular misalignment or a combination of both. Increased stresses and loads on connected equipment caused by misalignment can be prevented by careful installation of coupling. Coupling works regardless of direction of rotation. Construction is such that only coupling sleeve needs to be removed for maintenance. **John Waldron Corp., New Brunswick, N. J.**

Circle 22, inside back cover



Check valve for 0-3000 psi . . .

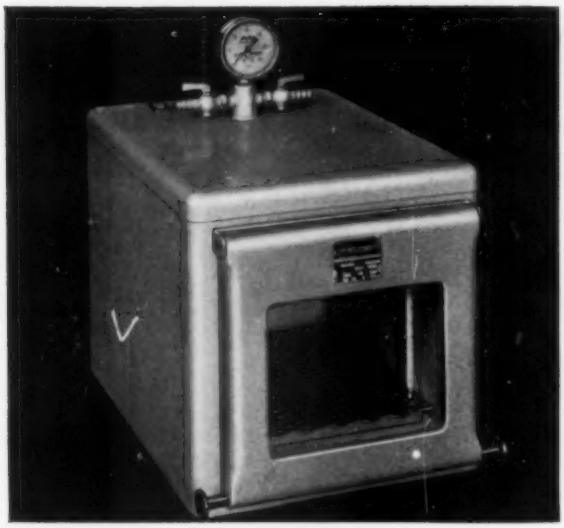
can be used for liquids, vapors and gases. Low pressures seat the poppet on a resilient disk inset in the body. As pressures increase, disk is radially displaced and a metal-to-metal seat results. Available in ¼ through 4 in. pipe sizes and ¼ through 1¼ in. tubing sizes. **Sealol Corp., 197 Post Rd., Providence 5, R. I.**

Circle 23, inside back cover

Multiple-circuit slide switch . . .

is rated at 10 amp, 125 v ac, has solid silver contacts, quick connect tab terminals, 2-hole mounting and an actuating switch arm designed for a snap-on plastic handle. Actuating arm has metal-to-metal bearing surfaces. Switch eliminates need for a mechanism between slide actuator and rotary switch. Housed in a steel case. Suitable for use on dishwashers, laundry

(Continued on page 104)



CORROSION-RESISTANT SHELVING

Precision Scientific Company, manufacturers of laboratory ovens, puts corrosion resistance into shelving by making it from nickel-plated, Penmetal expanded metal. Shelving stays bright and clean through many years of service. It is strong, yet weighs next to nothing.

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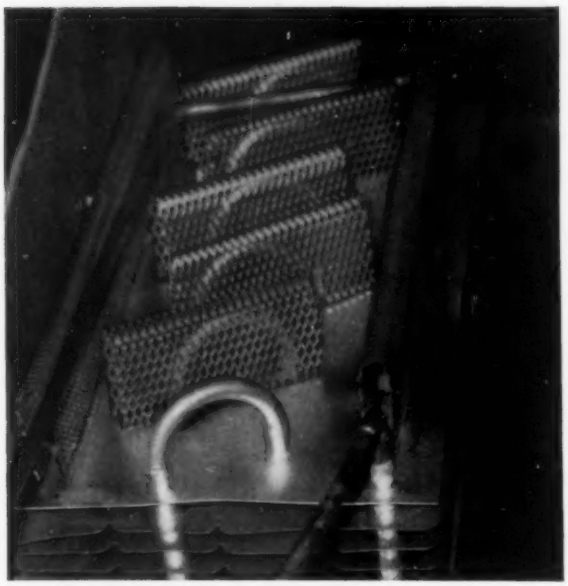
D. S. Kennedy & Co., found Penmetal expanded aluminum the ideal material for the huge reflectors of their radio telescopes. Inherent structural strength helps prevent distortion with movement of the reflector... corrosion resistance provides 'round-the-clock weather protection.

3 PRODUCTS—3 ADVANTAGES

of Penmetal expanded metal



FUNCTIONAL COIL COVERS

Anheuser-Busch, Inc., St. Louis, uses Penmetal expanded aluminum in their freezing unit to cover exposed ends of evaporator coils. This provides extra prime surface for frost collection on the cooling coils and fins—increases efficiency of the units.

Here are three applications, typical of thousands in which Penmetal expanded metal has been used functionally to improve design. The wide range of valuable properties inherent in expanded metal makes it the ideal material for many, many jobs.

Up to 80% lighter than solid sheet of its own area, the diamond-truss pattern adds rigidity and strength. Gives free passage to heat, light, sound and air. Comes in carbon steel and corrosion-resistant metals.

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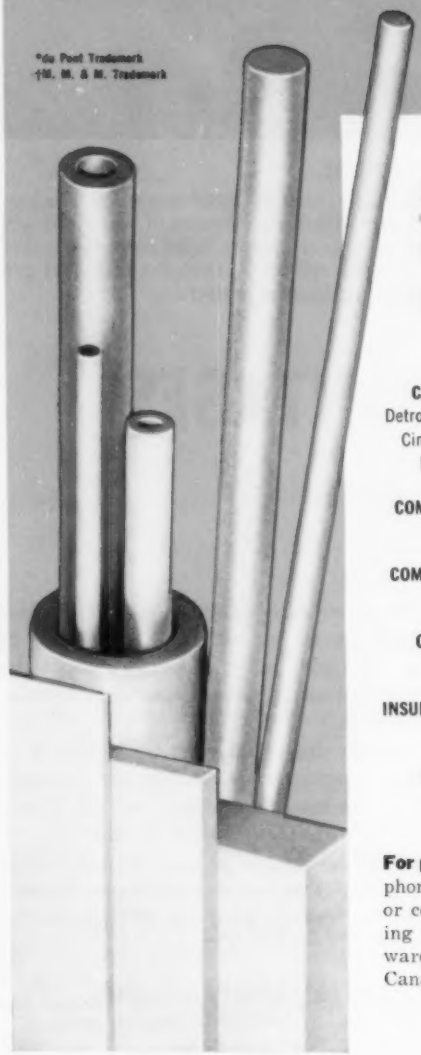

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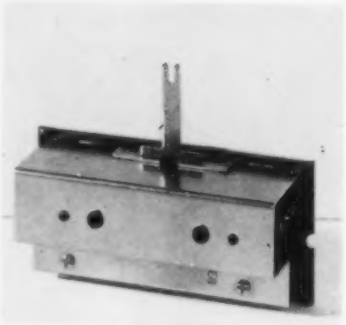
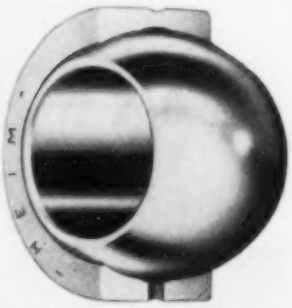


equipment, air conditioners, rotisseries, dehumidifiers. Dummy terminals can be furnished, also varied circuits, shunting, different mounting, various travel distances between positions, number of positions and an actuating arm to fit customers' requirements. **Accessory Equipment Dept., 1285 Boston Ave., Bridgeport 2, Conn.**

Circle 24, inside back cover



Cutaway shows large surface-supporting area

Sintered metal bearings . . .

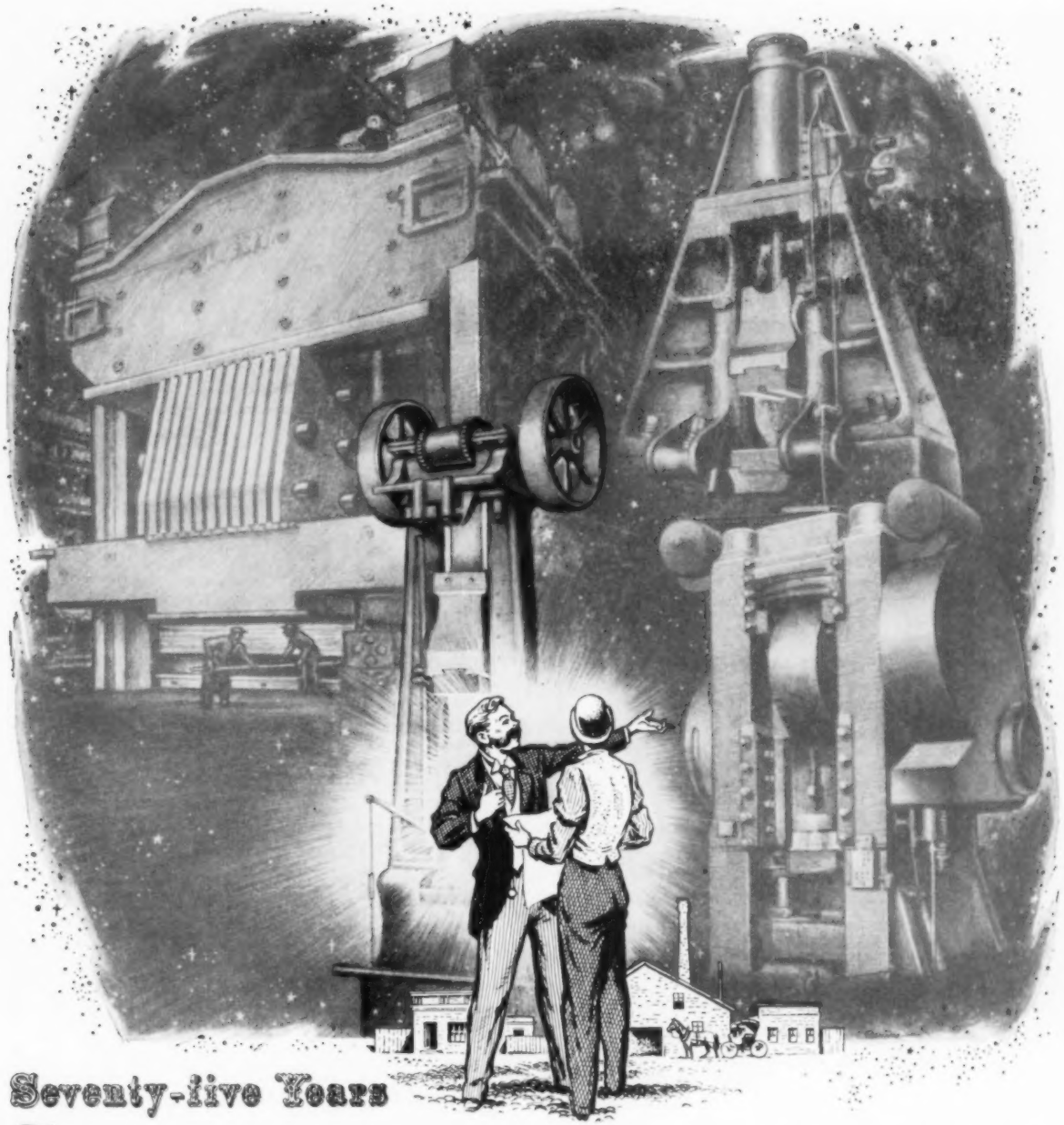
are produced by a series of controlled thermal, physical-chemical and mechanical steps. Balls are made from high-density, through-hardened powdered iron alloy; outer members from sintered iron or sintered bronze with controlled porosity. Spherical bearings hold up to 20% of their own volume in oil. Tests on a ⅞-in. bore bearing at 1350 rpm with a 30-lb load ran for 2000 hr with weekly lubrication. **Heim Co., Fairfield, Conn.**

Circle 25, inside back cover

Helical-gear speed reducer . . .

with either single or double-reduction gearing, can be mounted directly on driven shaft or stock bases. Four sizes provide output speeds of 10 to 431 rpm, capacities of ⅛ to 15 hp. Reducers are available for (1) V-belt, sprocket or gear drive to input shaft; (2) with motor; (3)

(Continued on page 106)



Seventy-five Years

THERE WAS a growing surplus in the United States Treasury—the Polygamy Act was passed—letter postage was reduced from three cents to two cents—the Brooklyn Bridge was opened—standard time was adopted—in 1883, when two young men, just graduated from Worcester Polytechnic Institute, established the business bearing their names—WYMAN-GORDON. The total capital was $27,000.

Integrity, initiative, ambition and ability were theirs. Endowed with these qualities and privileged to operate under that unique American system of free, private, competitive enterprise the Company prospered and grew.

On this our 75th anniversary, we salute the spirit of our founders and we pledge our every effort to help preserve, against the steady erosion of the last quarter century, that system which has made our nation what it is today and which has enabled us to build the greatest industrial production in the world, resulting in the highest standards for all segments of our people.

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NEW G-E PRE-AGED GLOW LAMP has starting voltage stabilized within ±8 volts

3 DIAMETER ENLARGEMENT

GENERAL ELECTRIC NE-81 GLOW LAMP (pre-aged, stabilized version of the NE-2)

STARTING VOLTS—72 ±8 volts.

HIGH INSULATION RESISTANCE—G-E "Drifilm" treatment insures minimum leakage resistance of 100 megohms under high humidity.

REDUCED DARK EFFECT—Higher-than-normal starting voltage in darkness now reduced with a mild, radioactive additive.

ANODE IDENTIFICATION—Permanent white dot marks positive lead.

PLATED LEADS—Cadmium plating permits easier soldering.

STARTING VOLTAGE RANGE is reduced in the NE-81 from the ±15 volts of the earlier NE-2 to a ±8 volts—a cut of nearly 50%.

Precision "seasoning" of the NE-81 under ideal conditions now delivers a component permitting circuit design based on closely fixed and stable glow lamp specifications. Dependable characteristics are assured—lamp to lamp, lot to lot.

The extreme precision, long life and rugged construction of the NE-81 makes it ideal for many applications such as: relaxation oscillator, leakage indicator, switch, voltage regulator or voltage indicator.

For further information write: General Electric Co., Miniature Lamp Dept. PE-78, Nela Park, Cleveland 12, Ohio.

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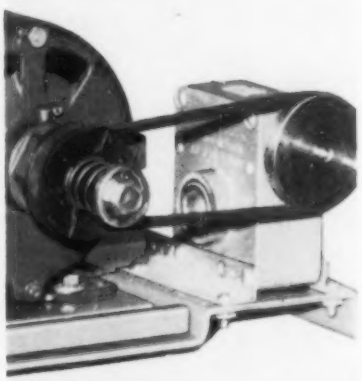
GENERAL ELECTRIC

without motor but ready for attachment to motor of choice. **Boston Gear Works, 14 Hayward St., Quincy 71, Mass.**

Circle 26, inside back cover



Plastic speed reducer . . .

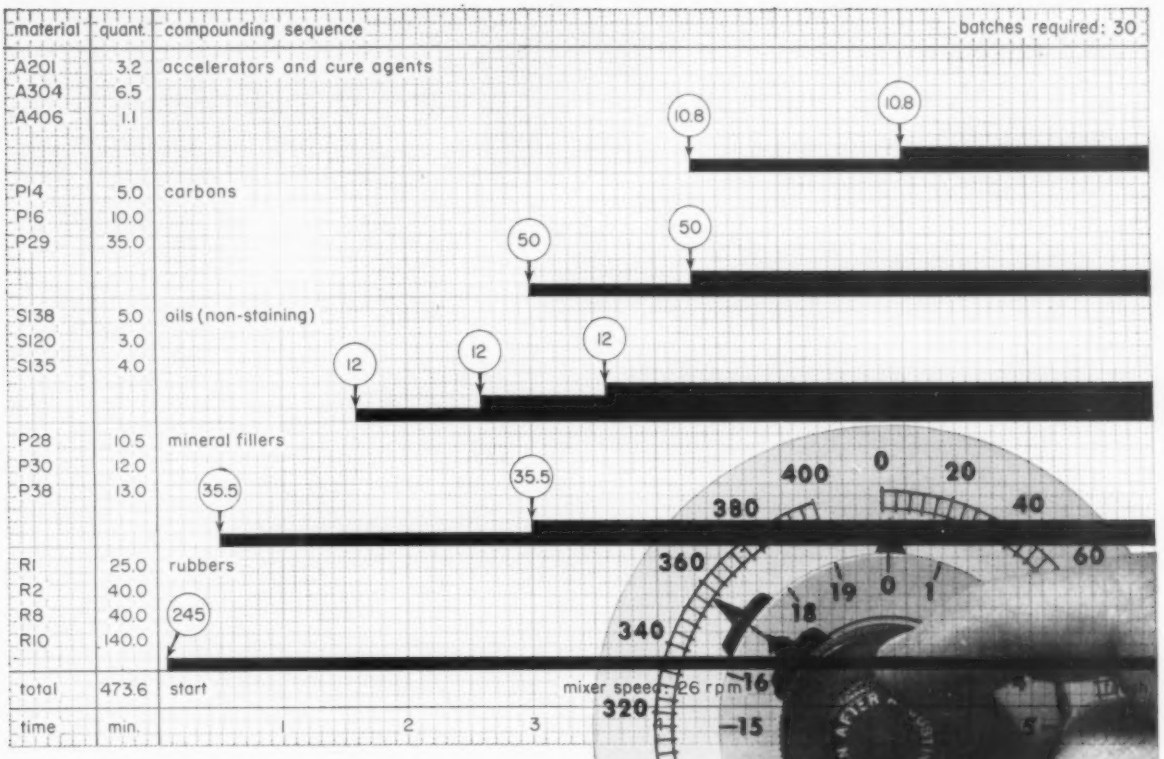
and variable-speed pulley are molded of fiber glass-reinforced nylon, except the machined shaft, worm gear and tension spring. Reducer offers reduction ratios of 10:1 to 60:1 and can be furnished with solid or hollow output shaft. Weighs less than 3 oz and measures $3\frac{3}{4}$ x $3\frac{7}{8}$ x $3\frac{1}{8}$ in. deep over-all. Pulley has a range of $2\frac{1}{4}$ times, with spring-loaded tension spring and shaft bores of $\frac{1}{4}$, $\frac{7}{16}$ and $\frac{3}{8}$ in. Measures $1\frac{5}{8}$ in. OD with $1\frac{3}{8}$-in. max pitch dia. Larger size is available for heavier duty. Both units are offered in various sizes for specific applications. Suitable for appliances, light machinery and any drive assembly with $\frac{1}{2}$, $\frac{3}{8}$ and $\frac{1}{4}$-in. V-belts. **Rampe Mfg. Co., 14915 Woodworth Ave., Cleveland 10.**

Circle 27, inside back cover

Circuit-breaking receptacles . . .

are dust- and ignition-proof. Front contact assembly must be fully engaged by plug before it can be rotated and moved to engage rear contacts, completing circuit. Plug cannot be withdrawn until front assembly has been disconnected from rear

(Continued on page 108)



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Here is just another reason why Ohio Rubber is widely recognized as an outstanding producer of "customeered" parts from rubber, synthetic rubber, silicone rubber, polyurethane and flexible vinyl—whether molded, extruded or bonded to metal.

From components weighing less than a gram to parts of over 73 lbs., complete ORCO facilities for design, production, as well as electronically controlled mixing, are prepared to handle your most exacting rubber and vinyl component requirements. Let ORCO CUSTOMEERING help you with your very next component problem.

Send for free booklet "Component CUSTOMEERING rubber and vinyl parts".

ORCO

THE OHIO RUBBER COMPANY

WILLOUGHBY, OHIO

A DIVISION OF THE EAGLE-PICHER COMPANY

EAGLE EP PICHER

Here's the **NEW** variable-speed, explosion-proof Model 16AM

GAST rotary vane AIR MOTOR

Newest and largest Air Motor in the Gast line, this Model 16AM may solve an original equipment (or plant use) problem for you! It's compact — only 14⅜" x 8" x 7⅝" high. It's light in weight — only 65 pounds. It delivers up to 7 h.p. with good torque characteristics.

Listing at $200, it offers unique advantages for driving equipment located near a compressed air source:

1. **Speed infinitely variable from 300 to 2,000 r.p.m. with any simple air valve control. Air motors always run cool.**
2. **Explosion-proof design, safe in explosive atmospheres.**
3. **Can't burn out from overloads — stalling doesn't harm it.**
4. **Heavy-duty construction with ball bearings, dual seals.**
5. **Six vanes in rotor automatically take up their own wear for constant high efficiency and long life.**

Designed to operate on air pressures from 30 to 90 p.s.i., Model 16AM is suitable for driving direct, through gear box or pulley. Foot (base) is standard. End plate also has four tapped holes for flange mounting to gear box or other driven unit.

Perhaps you can use air power on a hoist, fan, pump, mixer or other product. Write today for new Bulletin 16AM.

GAST MANUFACTURING CORP., P.O. Box 117-V, Benton Harbor, Michigan

SEE CATALOG IN SWEET'S PRODUCT DESIGN FILE & A.S.M.E. CATALOG

GAST ROTARY

- **AIR MOTORS TO 7 H.P.**
- **COMPRESSORS TO 30 P.S.I.**
- **VACUUM PUMPS TO 28 IN.**

"Air may be your answer!"

assembly and rotated to starting position. In combination with recommended plugs, dead-front receptacles are circuit breaking up to full listed ratings of 20 and 30 amp. Models are grounded through shell or grounded through extra pole and shell and are for use in Class II, Group G hazardous locations. Available with two, three and four-poles. 20-amp receptacles are listed with plugs that fit cables from ¼ to ⅝ in. dia; 30-amp receptacles with plugs that fit cable from ½ to 1⅜ in. dia. **Crouse-Hinds Co., Syracuse 1, N. Y.**

Circle 28, inside back cover

Magnetic filters . . .

will trap ferrous particles of 2 to 3 microns, with claimed efficiency of 95.7%, at rated flow capacities of 20 gpm and 12 gpm (depending on model). **Wilkinson Mfg. Co., Fort Calhoun, Neb.**

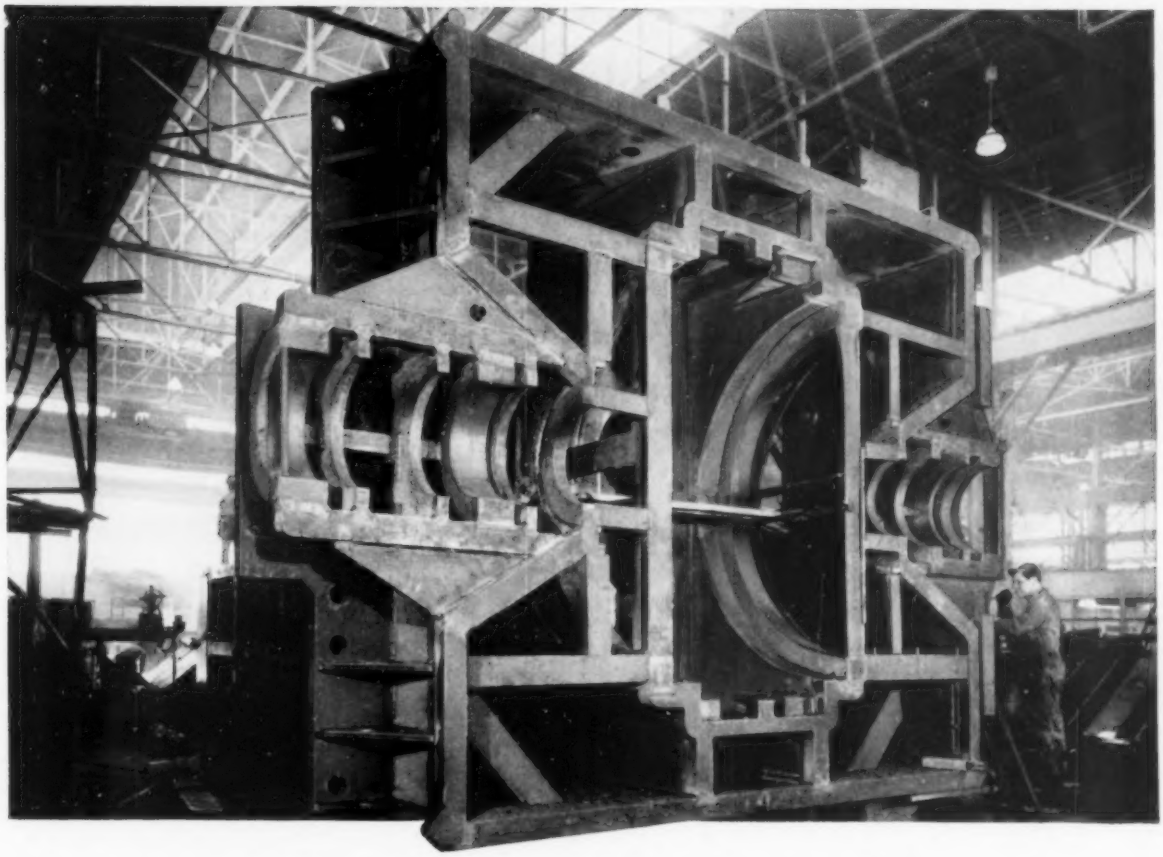
Circle 29, inside back cover

Tachometer generator . . .

mounts directly on driving motor. Stator bolts directly to motor flange, while rotor mounts on motor shaft. Ac output frequency is four times fundamental motor speed, producing 240 cps at 3600 rpm. Ac is induced in stator; rotor flux is supplied by a permanent magnet. Either output frequency or voltage may be used for speed indication as both are directly proportional to rotor rpm. Motor may operate in either direction. Permanent magnet rotor is air stabilized for consistent output. Design incorporates a one-piece

(Continued on page 110)

STEEL-WELD FABRICATION . . .



Less Weight in Heavy Machinery Components!

The 100-Ton Weldment illustrated above, in process of fabrication, is the base unit of a housing for a 300,000 kw Steam Turbine. It is a typical example of Mahon's capabilities in the field of heavy plate fabrication.

When you consider Steel-Weld Fabricated components for processing machinery, machine tools, or other types of heavy mechanical equipment, you, too, will want to discuss your requirements with Mahon engineers; because, in the Mahon organization you will find a unique source for weldments or welded steel in any form . . . a fully responsible source with a long and enviable performance record, and unusual facilities for design engineering, fabricating, machining and assembling.

See Sweet's Product Design File for information, or have a Mahon sales engineer call at your convenience.

Use WELDED STEEL for 100% Predictability and Greater Strength with Reduced Weight!

THE R. C. MAHON COMPANY • Detroit 34, Michigan

SALES-ENGINEERING OFFICES in DETROIT, NEW YORK and CHICAGO

MAHON

KRAISSL

Class 50

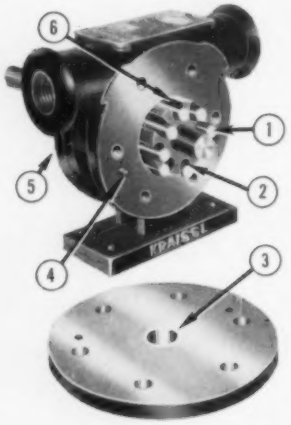
ROLLER PUMPS

For: Fuel oil, lube oil, hydraulic and coolant service

Pressures: to 100 psig (higher pressures under favorable conditions).

Capacities: 1 to 10 gpm in 4 sizes

Speeds: 1800 or 1200 RPM direct connection to motors or slower by reduction drives



Simple rugged design, with wide internal clearances—insures long life and permits operation under severe conditions—such as high temperatures, contaminated liquids—where more closely-fitted mechanisms would fail.

Check these design features:

1) **Hardened steel rollers provide rolling contact and minimum wear.**
2) **Design permits running at comparatively high speeds for viscous liquids.**
3) **Interchangeable needle and journal bearings provide proper load carrying capacity for application.**
4) **Cap screw closure with dowel pin alignment insures easy access to pump interior.**
5) **Adjustable stuffing box, in rear of housing, with return seal and soft packing keeps shaft wear and chance of leakage to a minimum.**
6) **Wide pump clearances and floating rollers permit operation with some extraneous solids in pumpage and high operating temperatures.**

Write for Bulletin A-1330 on the class 50 pump—and general bulletin A-1803 for all Kraissl products.

KRAISSL CO. Inc.

289 Williams Ave. Hackensack, N. J.

mounting ring. Min size is 4½ in. dia and 2½ in. long. Carter Motor Co., 2773 A W. George St., Chicago 18.

Circle 30, inside back cover

Insulated magnet wire . . .

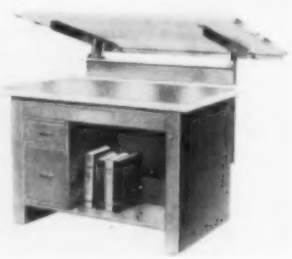
operates safely for long periods at temperatures exceeding 1000 F. Coated with a flexible ceramic enamel. Dielectric strength varies from 300 to 700 v/mil, depending on wire size and coating thickness. At present, nickel-clad copper in sizes 20 to 30 AWG is being coated. Coating is green-gray in color and offered in single and heavy thicknesses. Poor moisture resistance is said to be correctable by applying a thin top coat of Teflon. Will not burn. Now available in production quantities at $32.45 to $188.85 per lb, in 20- to 35-AWG sizes. Hitemp Wires, Inc., 1200 Shames Dr., Westbury, N. Y.

Circle 31, inside back cover

Drafting pencil . . .

for matte-surface Mylar film is smearproof, yet erases completely. Basic constituent is plastic, rather than graphite. Tracings can be cleaned with soap and water without loss of clarity, printed over without loss of detail, and reproduced clearly, even on microfilm. Drawing pencils are distinguishable by a gold band below black cap. Five degree designations from soft to hard are offered. Also supplied in drawing lead form for lead holders. Samples for testing and evaluation are available by letterhead request. J. S. Staedtler, Inc., Hackensack, N. J.

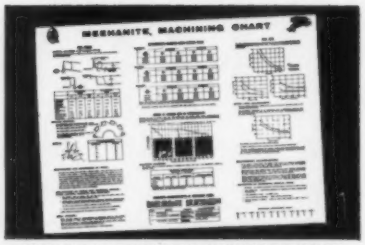
Circle 32, inside back cover



Drafting-reference unit . . .

combines a drafting surface for one man, desk and files for man in front of him. Placed in line, low-priced work stations eliminate need for separate reference tables. Has adjustable board height and slope, built-in electrical outlets, pull-out linoleum desk top and three steel drawers. Series includes standard, front and rear units in a range of base and board sizes. Stacor Equipment Co., 295 Emmet St., Newark 5, N. J.

Cicle 33, inside back cover



MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES

There are over 200 Meehanite foundries throughout the world. This advertisement is sponsored by the Meehanite Metal Corporation and the foundries listed below:

The American Laundry Machinery Co., Rochester, N. Y.
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Banner Iron Works, St. Louis, Mo.
Barnett Foundry & Machine Co., Irvington, N. J.
Blackmer Pump Co., Grand Rapids, Mich.
E. W. Bliss Co., Canton and Toledo, Ohio and Hastings, Mich.
Centrifugally Cast Products Div., The Shenango Furnace Co., Dover, Ohio
Compton Foundry, Compton, Calif.
Continental Gin Co., Birmingham, Ala.
The Cooper-Bessemer Corp., Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co., Portland, Ore.
Empire Pattern & Foundry Co., Tulsa, Okla. and Bonham, Texas
Florence Pipe Foundry & Machine Co., Florence, N. J.
Fulton Foundry & Machines Co., Inc., Cleveland, Ohio
General Foundry & Mfg. Co., Flint, Mich.
Georgia Iron Works, Augusta, Ga.
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The Hamilton Foundry & Machine Co., Hamilton, Ohio
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Hardinge Manufacturing Co., York, Pa.
Johnstone Foundries, Inc., Grove City, Pa.
Kanawha Manufacturing Co., Charleston, W. Va.
Kennedy Van Saun Mfg. & Eng. Corp., Danville, Pa.
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Palmyra Foundry Co., Inc., Palmyra, N. J.
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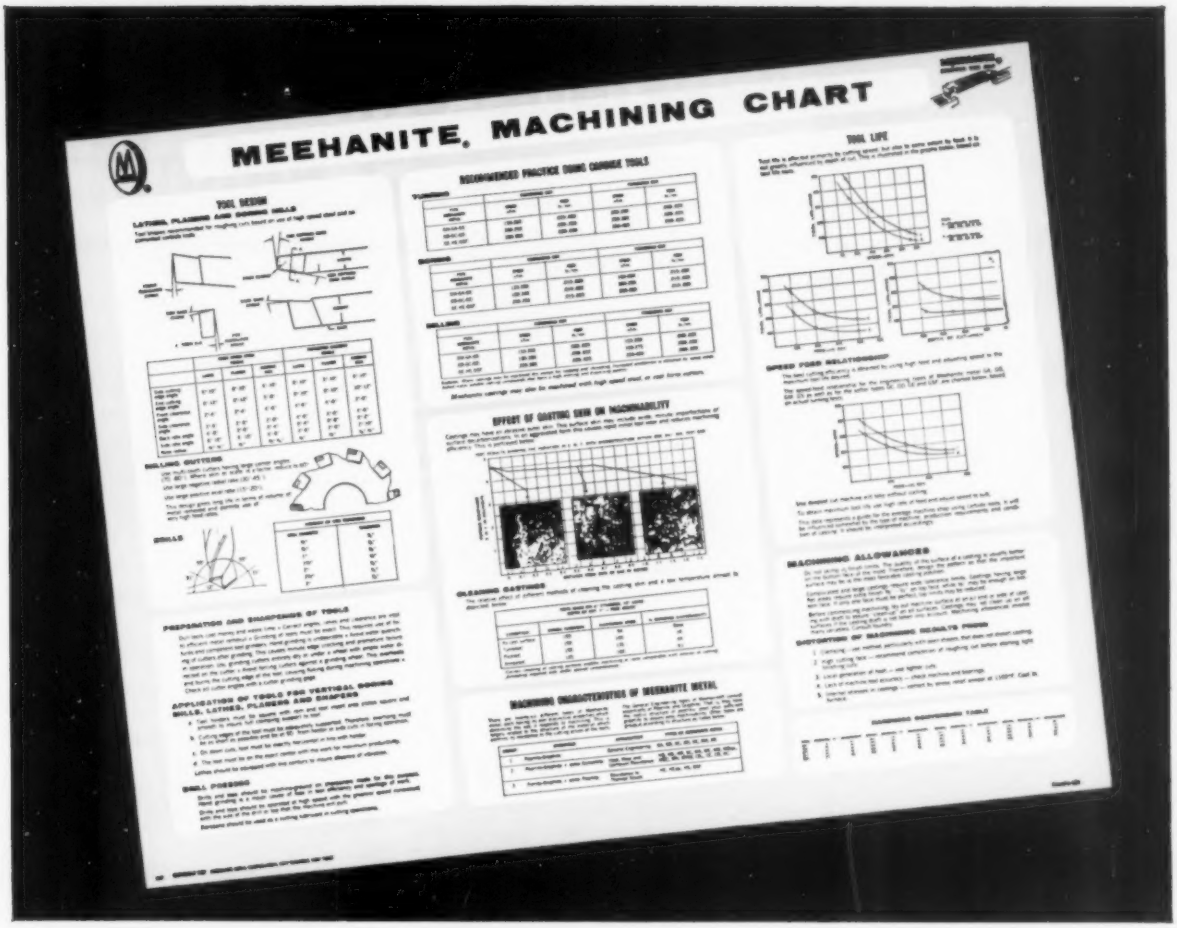
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
Ross-Meehan Foundries, Chattanooga, Tenn.
Sonith Foundries of FMC, Indianapolis, Ind.
Standard Foundry Co., Worcester, Mass.
The Stearns-Roger Mfg. Co., Denver, Colo.
Valley Iron Works, Inc., St. Paul, Minn.
Vulcan Foundry Co., Oakland, Calif.
Washington Iron Works, Seattle, Wash.
Dorr-Oliver-Long, Ltd., Orillia, Ontario
Hartley Foundry Div., London Concrete Machinery Co., Ltd., Brantford, Ontario
Otis Elevator Co., Ltd., Hamilton, Ontario

WRITE TODAY FOR YOUR FREE SINGLE COPY OF THE NEW MEEHANITE MACHINING CHART

Write today to Meehanite Metal Corporation, Department 7G, 714 North Avenue, New Rochelle, N. Y.

MEEHANITE ®



New Meehanite Wall Chart presents useful data on machining castings

Designed as a working chart for use in every machine shop, this new, two color, 18 x 24 wall chart contains considerable machining data that has been heretofore unobtainable. This lack of data has created many problems and has placed foundries and machine shops at a distinct disadvantage, particularly in view of the fact that the cost of machining is often considerably more than the cost of the casting.

The extensive information presented in this machining chart is the result of years of research and development by the Meehanite Metal Corporation and Meehanite foundries throughout the world.

The various aspects of machining covered, include tool design for lathes, planers, boring mills, milling cutters and drills; preparation and sharpening of tools; applications of tools for vertical boring mills, lathes, planers and shapers, and drill presses; recommended practices using carbide tools; effect of casting skin on machinability; tool life, speed-feed relationship, machining allowances, etc.

If you would like a free single copy of this informative machining chart, please write today to the Meehanite Metal Corporation, New Rochelle, New York.

MEEHANITE BRIDGES THE GAP BETWEEN CAST IRON AND STEEL®

MEEHANITE METAL

MEEHANITE METAL CORPORATION, NEW ROCHELLE, NEW YORK

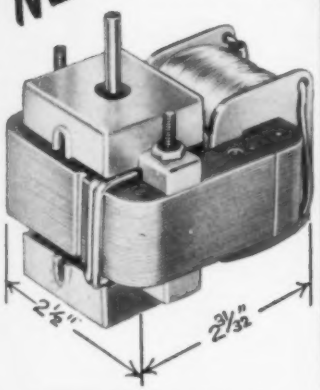
GENERAL INDUSTRIES

Smooth Power

AC MOTORS

1/1800 H.P. to 1/35 H.P.

NEW! 2-POLE, SHADED-POLE MOTOR 1/550 HP to 1/50 HP



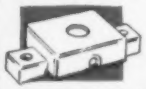
Designed and Constructed with Features That Insure

EXTRA YEARS OF SERVICE

When exceptionally long service is a must, you can rely on GI's new Model H, 2-pole, shaded-pole motor. The Model H is constructed with many outstanding features that assure thousands of EXTRA HOURS of service under the most adverse operating conditions. Available in nine models that cover a wide range of applications.

OIL CAPACITY MANY TIMES GREATER THAN CONVENTIONAL MOTORS Oversized oil bearing reservoirs hold considerably more oil and wicking assuring more efficient lubrication over a longer period of time.

REVOLUTIONARY METHOD OF PACKING THE OIL WICKING A unique new method of packing the oil wicking assures equal oil distribution at all times resulting in quieter operation and longer, trouble free life.



DIE-CAST BEARING BRACKET This new "H" Motor design includes a rugged die-cast bearing bracket that insures permanent precision alignment and adds to the over-all durability.

Write today for catalog sheet and quantity-price quotations.

THE GENERAL INDUSTRIES CO.

DEPARTMENT GK • ELYRIA, OHIO

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

REMOTE-MECHANICAL CONTROLS—Catalog, about 96 pp. Lists line of connector, push-pull, locking, lever, converter, vernier and special design controls and accessories. With photos, engineering drawings, dimensional information and descriptions. Indexed for reference and filing. Arens Controls, Inc., 2017 Greenleaf St., Evanston, Ill.

Circle 34, inside back cover

ELECTRONIC AND ELECTRICAL COMPONENTS—Catalog W600, about 76 pp. Lists components, with dimensional drawings and specifications. Blueprint presentation of coils, terminals and hardware is broad enough to serve designer. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.

Circle 35, inside back cover

QUICK-CONNECT COUPLINGS—Catalog, 26 pp. Describes five basic couplings, illustrates their construction details by cutaway drawings and pictures, and describes spare parts and accessories. Also gives dimensions. Flow and pressure-drop data is shown by graphs and tables as well as listing temperature range. With ordering information. Snap-Tite, Inc., Union City, Penna.

Circle 36, inside back cover

LIQUID-LEVEL CONTROL—Brochure, 16 pp. Describes system which operates without floats and with no moving parts in liquid. Includes descriptions, charts and diagrams of typical applications. Shows panels for liquid level and industrial controls. B/W Controller Corp., 2200 E. Maple Rd., Birmingham, Mich.

Circle 37, inside back cover

PNEUMATIC PRODUCTS—Catalog 616, 20 pp. Air-line filters, regulators and lubricators are described. Gives performance characteristics, sizing charts and specifications. With cutaway and dimensional drawings. Watts Regulator Co., Industrial Div., Lawrence, Mass.

Circle 38, inside back cover

GLASS MERCURY SWITCHES—Booklet, 8 pp. General description followed by life-size line drawings and specifications of individual models. Gives current ratings. Gordos Corp., 250 Glenwood Ave., Bloomfield, N. J.

Circle 39, inside back cover

ALUMINUM FLATTENED WIRE—Folder, 6 pp. Specifications, engineering data and availability of wire. Discusses advantages, economies and performance characteristics. With charts on mechanical and physical properties. Kaiser Aluminum & Chemical Sales, Inc., Dept. NR-15, 919 N. Michigan Ave., Chicago 11.

Circle 40, inside back cover

INDEX TABLES—Catalog 302, 12 pp. Gives design characteristics of roller-gear-drive indexing mechanism in index tables and rotary transfer machines. With performance data, specification tables, engineering drawings and dimensional information. Ferguson Machine Corp. of Indiana, 7818 Maplewood Industrial Court, St. Louis 17.

Circle 41, inside back cover

TORQUE ACTUATORS—Catalog 26-282, 20 pp. Describes line of rotary oscillating torque actuators. Lists 26 standard styles and 12 modifications. Includes dimensional, mounting data and torque ratings. Also, two pages of engineering facts and formulae. Ex-Cell-O Corp., 945 E. Sater St., Greenville, Ohio.

Circle 42, inside back cover

FLEXIBLE COUPLINGS—Bulletin 101-00A, 8 pp. Revised edition covers new additions to line. Selection data and other engineering tables have been revised, too, to handle these new couplings. Tables also include newly designed couplings with ductile-iron flanges and a special steel retaining ring and specially balanced couplings. T. B. Wood's Sons Co., Chambersburg, Penna.

Circle 43, inside back cover

SCREW MACHINE BLANKS—Folder 1, 2 pp. Discusses design, production and application data on screw machine blanks that were engineered for critical tolerances. Illustrates and describes blanks, detailing pistons in various stages of production. Engineering drawings give specifications. National Screw Machine Products Association, 2860 E. 130th St., Cleveland 20.

Circle 44, inside back cover

TEFLON-COATED WIRE—Fact sheet 2, 4 pp. Describes wire, sizes available, engineering data, pointers on wire and

(Continued on page 115)

Moline link attachments adapt Moline Chains to many jobs

STANDARD ATTACHMENTS
Only a few of the wide variety of Moline Chain attachments are shown here.

Conveying and Elevating

THERE IS NO LIMIT to the number of jobs which can be handled by Moline Chains. With the wide variety of standard link attachments available, the possibilities for adaptation are endless. Both right and left hand types are made to the exact size and pitch of the regular chain links.

With Moline Chain, equipped with standard attachments, you can push, pull, scrape, elevate and carry an endless variety of materials and objects.

At the same time you can cut your overall chain costs because Moline Chains and attachments are engineered for maximum efficiency . . . trouble-free performance . . . and long life. Only Moline Chains are triple-tested to guarantee maximum quality control.

Write for descriptive literature today!

Moline MALLEABLE Chains

Specializing in the manufacture of chains

LEADER FOR 60 YEARS

MOLINE MALLEABLE IRON COMPANY
St. Charles, Illinois

CIRCLE 170 READER SERVICE CARD

TEN-TO-ONE THE

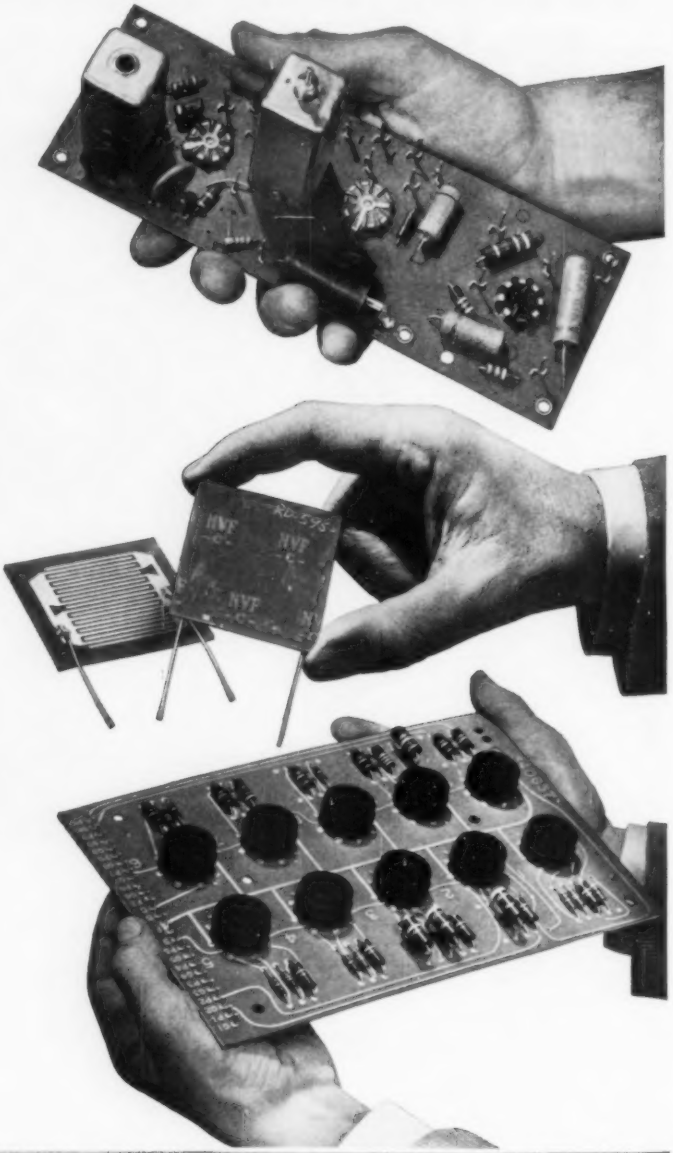
Copper Clad Laminate

YOU WANT IS HERE!

From these ten basic PHENOLITE® Grades, you can select the base material, resin, properties and price to fit your present printed circuit need.

If your problem is finding a suitable cold-punch material, try samples of XXXP-470-1. It's designed for use in automated production equipment. If you are looking for higher heat resistance, check Grades G-10 and G-11.

Out of National's research laboratories come new advances every day. See your National Representative about new products and applications. He can keep you posted on the full line of PHENOLITE Laminated Plastic, Vulcanized Fibre and National Nylon for electronic applications across-the-board. In the meantime, write for our new "PHENOLITE Copper Clad Data" folder. Address Dept. H-7.



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VULCANIZED FIBRE CO.
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Over 100 Grades
sheets • rods • tubes • rolls • fabricated parts

National Vulcanized Fibre
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TYPICAL TEST VALUES ON COPPER CLAD PHENOLITE

GRADE	PROPERTIES OF BASE MATERIAL					COPPER CLAD PROPERTIES				RELATIVE COST
	Dielectric Constant	Dissipation Factor	Moisture Absorption	Flexural Strength	Maximum Operating Temperature	Copper Bond Strength		Hot Solder Resistance	Surface Resistance	Based on XXXP as Arbitrary Scale of 1
	10^6 Cycles	10^6 Cycles	⅛", % 24 Hrs	Psi	Degree F	Pounds to Pull 1" Strip		Secs to Blister 1" Square > Greater Than	Megohms, Etched Retma Comb Pattern, 96 Hrs/35°C/90% RH	⅛" Thk. 1 Oz. Copper 1 Side
						1 Oz	2 Oz			
P-214-B-1	5.3	.040	2.20	18,000	250	8	11	>10@ 475°F	100,000	.81
XXP-209-G-1	4.6	.037	1.30	17,000	250	8	11	>10@ 475°F	200,000	.92
XXP-239-1 PHENOCLAD	4.2	.035	0.67	15,500	250	8	11	>10@ 475°F	200,000	.92
XXXP-219-C-1	4.5	.030	0.70	15,500	250	8	11	>10@ 475°F	500,000-1,000,000	1.00
XXXP-455-1	4.0	.026	0.55	23,500	250	8	11	>10@ 475°F	1,000,000-1,500,000	1.00
XXXP-470-1	3.7	.027	0.48	14,000	250	8	11	>10@ 475°F	300,000-500,000	1.00
N-1-852-1	3.3	.030	0.20	16,000	165	8	11	>10@ 450°F	2,000,000	2.69
G-5-813-1	6.8	.018	1.00	55,000	300	8	11	—	—	2.98
G-10-865-1	5.2	.012	0.13	60,000	250	10	15	>30@ 500°F	1,500,000-2,000,000	3.49
G-11-861-1	4.9	.015	0.17	60,000	300	10	15	>30@ 500°F	2,000,000	3.55

cable design with Teflon and typical uses. Chemplast, Inc., 3 Central Ave., East Newark, N. J.

Circle 45, inside back cover

ELECTRICAL AND LUBRICATING DEVICES–Condensed catalog 58, 8 pp. Explains use of various types of equipment. Features recently developed products. With descriptions, sizes and capacities. Illustrated. Trico Fuse Mfg. Co., 2948 N. 5th St., Dept. PE, Milwaukee 12.

Circle 46, inside back cover

ROTATING AND CONTROL EQUIPMENT–Brochure 4988, 6 pp. Describes motors, generators, alternators, motor-generators and motor-alternators, magnetic amplifiers, regulators, relays and other control equipment, high-frequency motor-generators for induction heating applications, mobile air-conditioning units and motor brakes. Illustrated with photos. Safety Industries, Inc., P.O. Box 904, New Haven, Conn.

Circle 47, inside back cover

INDUSTRIAL WHEELS–Catalog 157-W, 6 pp. Illustrates and gives specifications for wheel types, sizes and shows various bearings. Wheel selection table is included. Faultless Caster Corp., Evansville 7, Ind.

Circle 48, inside back cover

VARIABLE-SPEED CONTROL – Brochure F-1882, 8 pp. Describes operation and application of variable-speed drive and pneumatic control systems. Announces pre-engineered instrumentation packages. Illustrated 4-color brochure tells how speeds may be set up and maintained automatically. U.S. Electrical Motors, Inc., P.O. Box 2058 Terminal Annex, Los Angeles 54.

Circle 49, inside back cover

TRANSISTOR-EQUIPPED ANALOG-TO-DIGITAL CONVERTER–Technical bulletin 50DC1000, 1 pp. Gives specifications, operational data and characteristics of unit. With performance data and dimensions. Illustrated. Fischer & Porter Co., 790 Jacksonville Rd., Hatboro, Penna.

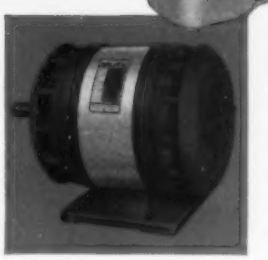
Circle 50, inside back cover

PRECISION GEARS–Brochure 5811, 4 pp. Illustrates types of UQ fine-pitch gears available gives typical applications. Western Gear Corp., P.O. Box 182, Lynwood, Calif.

Circle 51, inside back cover

MINIATURE LAMPHOLDERS–Data sheet, 1 p. Lampholder and bracket combinations for use with 2-pin lamp are described, and 13 combinations are illus-

(Continued on page 116)



BALDOR
Streamcooled
MOTORS
BALTRIC LINE

For general use or for specific applications demanding the most exacting requirements, the Baltric line of motors more than fills the bill. One reason is the "Monocast" Stator shown above.

Steel laminations in an aluminum alloy casting form a stator frame of greater stability . . . greater rigidity. This permits the use of a new and better slot design. The result is uniform magnetic flux distribution throughout the motor—gives more power, greater efficiency, higher power factor and quieter operation.

If you're interested in getting top efficiency from your equipment while holding costs to a minimum, investigate the Baltric line of motors—without obligation! Just write . . .

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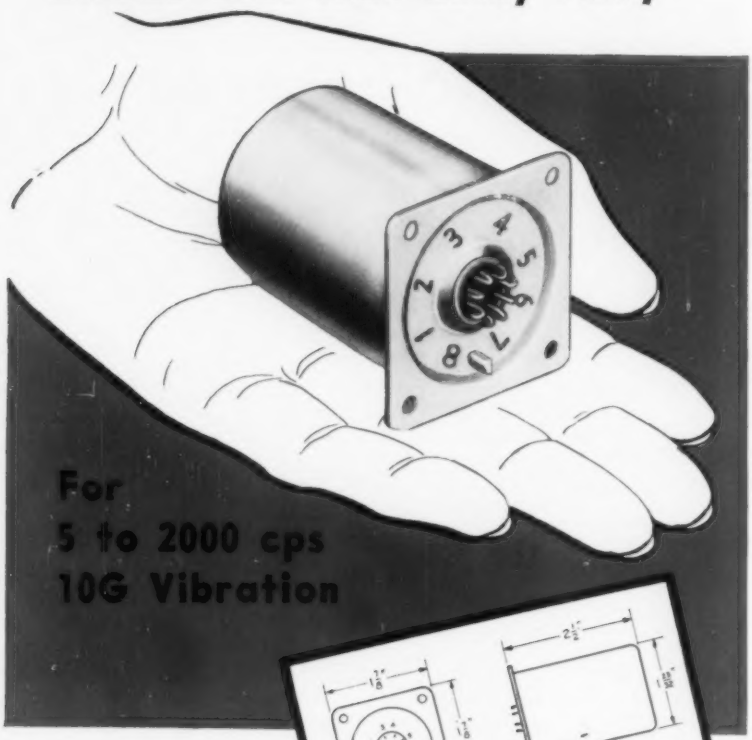
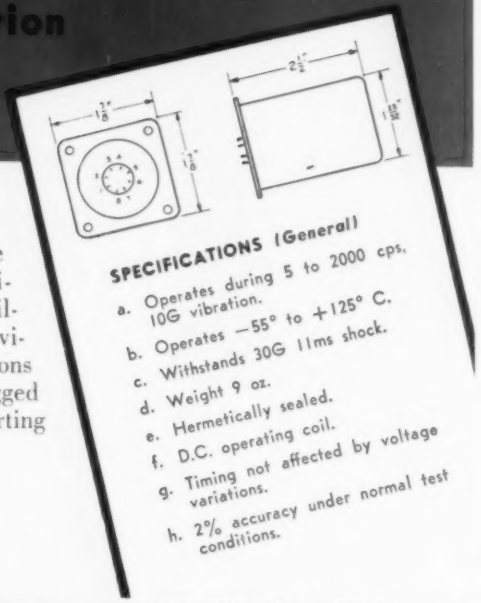
NEW! TYPE AX1

EAGLE D.C. time delay relay



For
5 to 2000 cps
10G Vibration

Uses new type escapement principle. Utmost reliability under severe environmental conditions is insured by its rugged design and self-starting characteristics.



SPECIFICATIONS (General)

a. Operates during 5 to 2000 cps, 10G vibration.
b. Operates −55° to +125° C.
c. Withstands 30G 11ms shock.
d. Weight 9 oz.
e. Hermetically sealed.
f. D.C. operating coil.
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trated, with dimensional information. Drake Mfg. Co., 1711 W. Hubbard St., Chicago 22.

Circle 52, inside back cover

MICROFILM SYSTEM FOR DRAWINGS—Brochure, 16 pp. Presents filing system for engineering drawings and allied records. Traces basic procedures in transforming original drawing to microfilm, inserting the film into the card, viewing and enlarging card, and use of new techniques for printing and copying film. Filmsort Co., Pearl River, N. Y.

Circle 53, inside back cover

COOLING PACKAGES—Brochure, 4 pp. Describes component construction and operation. Specifications present in chart form show operating characteristics of a typical package. Pesco Products, Borg-Warner Corp., Bedford, Ohio.

Circle 54, inside back cover

ASBESTOS-FIBER FILLER — Folder AFD-SA, 4 pp. Shows how plastics manufacturers can advantageously use this material as a filler. Table is given on properties of asbestos-filled plastic molding compositions and characteristics of asbestos fiber. Illustrations include a photomicrograph view of the fiber. Johns-Mansville, Box 1500, Asbestos, Quebec, Canada.

Circle 55, inside back cover

TITANIUM MACHINING — Brochure, 8 pp. Discusses fundamentals of machining titanium, factors that affect machinability, and basic requirements. Gives suggested speeds; feeds and tool angles; recommendations for abrasive, hack and band sawing. Data is also included on cutting tool for each type of titanium or its alloy being machined. Mallory-Sharon Metals Corp., Niles, Ohio.

Circle 56, inside back cover

SPECIALIZED HEAT TREATMENTS—Brochure, 8 pp. Covers protective-atmosphere furnace annealing, brazing and hardening of a variety of metals. Also, protective atmospheres in continuous, batch or pit-type furnaces. Ferrotherm Co., 1861 E. 65 St., Cleveland 3.

Circle 57, inside back cover

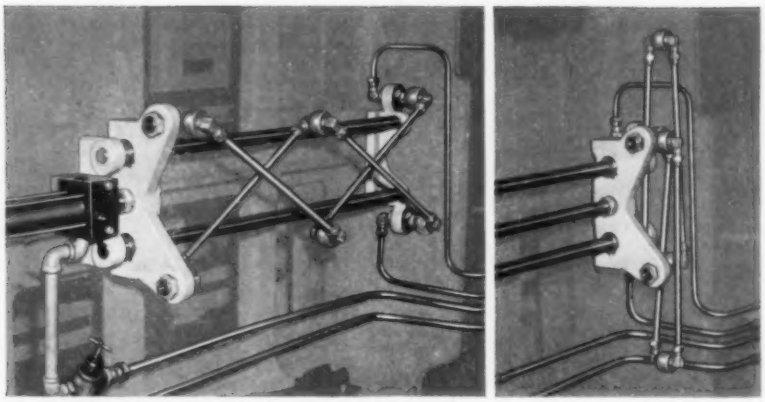
CABLE ASSEMBLY—Catalog CA-1, 24 pp. Gives information on all types of mechanical cables with specifications, drawings and photos covering wide range of assemblies and fittings for industrial application, other than electrical. Includes information on nylon-coated cable, swaging and other data of interest to design, such as how to select best cable construction for specific conditions. Bergen Wire Rope Co., Lodi, N. J.

Circle 58, inside back cover

IN EQUIPMENT DESIGN ■

CHIKSAN SWIVEL JOINTS

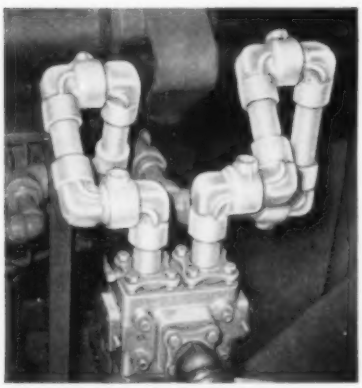
SMOOTH OUT KNOTTY LINE PROBLEMS



STEEL LINES FOLD LIKE AN ACCORDION

Connected to a moving head, these compact swivel jointed all-metal hydraulic lines flex and fold like an accordion on this automatic bottle unpacking machine.

When a machine's moving parts cause tight bend or twist on hose lines, Chiksan Swivel Joints provide a ready solution. When design dictates the use of metal lines, Chiksan Swivel Joints allow rubber-like flexibility. In fact, wherever line flexibility is required, designers and maintenance engineers know it's just good business to call on Chiksan. Precision made Chiksan Swivel Joints with their infinite service life, full 360° rotation and high safety factor, quickly pay for themselves by minimizing hose replacement and eliminating costly line failure, fluid loss and downtime. If your equipment hose lines require frequent replacement due to torsion or bend radii fatigue, or if flexible all metal lines are in order, contact Chiksan. A nearby representative will call, analyze your requirements, and make specific recommendations. Write today for his name.

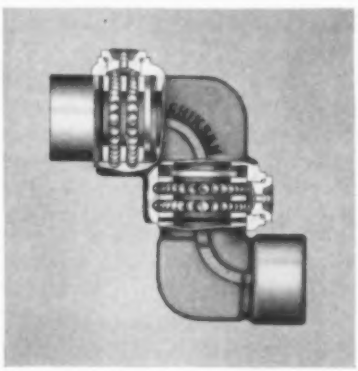


NO HOSE BURST HERE

These Chiksan swivel jointed steel lines on a die casting machine eliminate damaging hose ruptures, reduce fire hazard, fluid loss and setup time by 75%.

NO BEND FATIGUE HERE

This highly specialized lens grinder utilizes Chiksan Swivel Joints to eliminate tight hose bend as the multiposition head is shifted from one grinding position to another.



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DESIGN ABSTRACTS

Tubes Under Combined External Pressure and Axial Load

Relationship between external pressure and axial load at failure was investigated for tubes which fail by plastic buckling under external pressure alone. Experimental techniques and observations are given. An attempt is made at correlating results with relevant formulae for elastic materials.

Abstracted from "Failure of Tubes Under Combined External Pressure and Axial Load," by W. Stuiver, General Electric Co., and P. F. Tomalin, English Electric Co.; Society for Experimental Stress Analysis paper 479, Central Square Station, P.O. Box 168, Cambridge 39, Mass.

Tangential Residual Stress Distribution in Curved Beams

A method of determining tangential residual stress distribution in curved beams of rectangular cross-section is based upon the fact that when a thin layer is removed from the periphery of the beam, radius of curvature of beam changes. Stress in the layer removed may then be calculated —laboriously on a desk calculator, more easily with a computer.

Abstracted from "A Theory for the Calculation of Tangential Residual Stress Distribution in Curved Beams," by J. L. Rembowski, General Motors Corp.; SESA paper 473, Central Square Station, P.O. Box 168, Cambridge 39, Mass.

Reporting Through the Looking Glass

Present courses in report writing are criticized and the necessary ingredients of improved methods of study and preparation of reports are described.

Abstracted from "Reporting Through the Looking Glass," by W. W. Wood, Convair; Journal Engineering Education, May 1958, Prince and Lemon St., Lancaster, Penna.

Lubricating Oils Under Pressure

Flow properties are described in terms of Newtonian and non-Newtonian units. By introducing results into Ree-Eyring theory of non-Newtonian flow, a new equation is derived, which is applicable to sperm oil, SAE 30 motor oil, lard oil, castor oil, naphthenic petroleum, paraffinic petroleum, a synthetic lubricant. Effect of pressure on some lubricating greases is also discussed.

Abstracted from "Flow Properties of Lubricating Oils Under Pressure," by Hahn, Eyring, Higuchi and Ree; NLGI Spokesman, 4638 J. C. Nichols Parkway, Kansas City 12, Mo.

Low-density Foams as Energy Absorbers

Because most of the energy-absorbing plastic foams do not have linear spring rate characteristics under impact, they do not lend themselves to simple mathematical analysis. Better energy-absorbing foams resist impact with nearly constant pressure for approximately ¾ their thickness. Dynamic pressure characteristics cannot be determined by static compression tests. Foams of same density and rigidity but different formulations do not necessarily have same energy-absorbing characteristics, and they get stiffer as temperature drops. Auxiliary structures such as sheet metal back-up panels distribute force over a larger area of foam.

Abstracted from "Mechanical Properties of Low-density Foams as Energy Absorbers," by E. R. Dye and M. D. Smith, Cornell Aeronautical Laboratory, Inc.; presented at Semi-annual ASME Meeting, June 15-19, 29 W. 39th St., New York 18.

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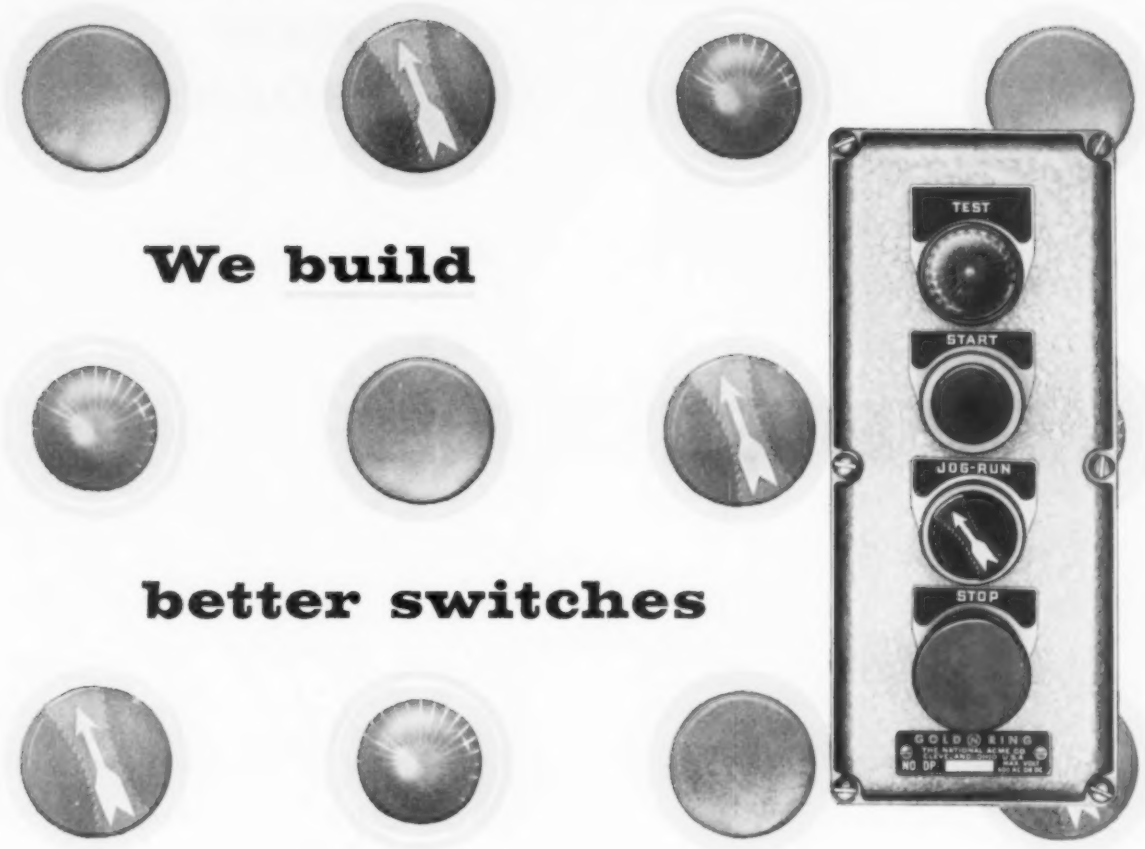

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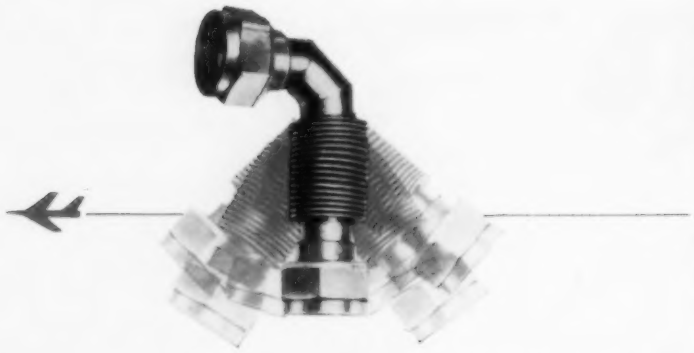
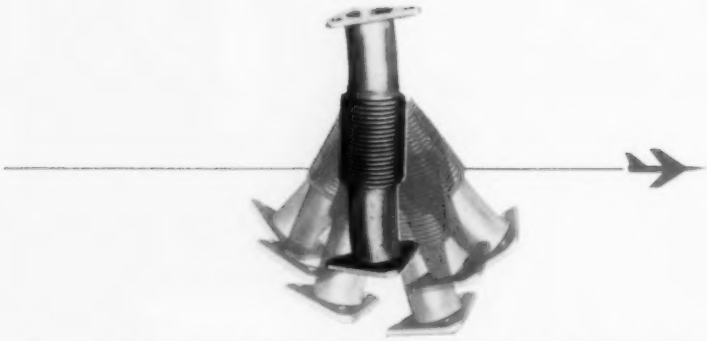


FATIGUE RESISTANCE



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NEW BOOKS

The Measurement of Thickness

GEORGE KEINATH, *National Bureau of Standards Circular 585. Published by Superintendent of Documents, Government Printing Office, Washington 25, D. C. 8 x 10½, 80 pp. $0.50.*

Surveys various methods and problems of measuring thickness frequently encountered in science and industry. Methods are treated in seven groups, according to physical operating principles: mechanical, chemical, electrical, magnetic, optical, X-ray, and radioactive radiation.

The circular includes photos and diagrams and discusses range, accuracy, advantages and limitations of each method. A bibliography of references, a limited list of suppliers, and a detailed index of gages, methods, applications, and trade names are appended.

Unconventional Electrical Power Sources, Parts 1 and 2

PAUL A. MCCOLLUM, *Air Research and Development Command, US Air Force. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Approximately 66 pp, 8 x 10½. $2 each.*

Solar energy converters, fuel cells, thermopile generators, and a dozen other new and unusual devices for turning heat, chemical and mechanical energy into electric power are described in this 2-part Wright Air Development Center report. It provides a good brief review of the history and current status of each.

Conveyor Terms and Definitions

Book No. 101. Published by Conveyor Equipment Manufacturers Assn., 1 Thomas Circle, Washington 5, D.C. 8½ x 11, 95 pp. $2.

An up-to-date and enlarged edition of an earlier publication, this pamphlet defines more than 1200 conveyor types, parts and related equipment. It is illustrated with over 100 line

(Continued on page 123)

STOP, ADMIRAL WHITEHEAD! ...DON'T SHOOT

THERE'S ONLY ONE OF THOSE IN EXISTENCE!

No need to worry. One more, or a thousand, of these special Reuland Power Packages could be quickly produced. The original drawings are permanently filed in our famous *Special-Motor Library*.

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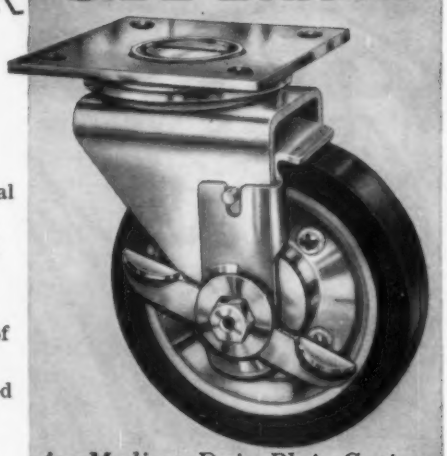

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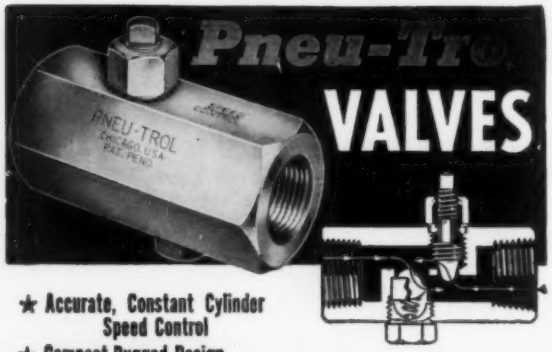

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drawings. "Preferred" terms are accompanied by a complete definition while other commonly used terms are listed and referred to by an extensive system of cross-indexing. Also included is a list of trade names and a directory of the members of the Association.

A Management Guide to Electronic Computers

WILLIAM D. BELL. *Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36.* 9½x9½, 403 *pp.* $6.50.

In nontechnical language, this book discusses such questions as: what jobs are electronic data-processing set-ups good for? what equipment is necessary? how do they work? what results and what problems will these machines bring? how to choose and install a system? Answers to these questions are illustrated with actual case histories. To clarify programming, an analysis of Dow Jones stock market averages shows how they were programmed on three prominent systems.

Atoms for Power

WALTER H. ZINN, SIR JOHN COCKCROFT, *American Assembly at Arden House, Columbia University,* 6 x 9, 165 pp. $1.00.

These are background papers, prepared for the American Assembly at Arden House, Columbia University, by such leaders in the field as the authors (Zinn is head of Argonne National Laboratory; Cockcroft is di-

(Continued on page 124)

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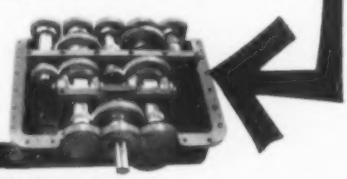

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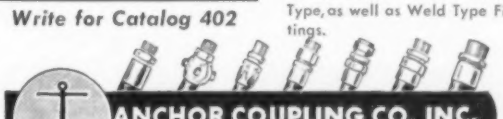

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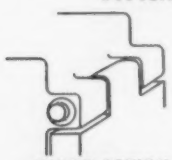
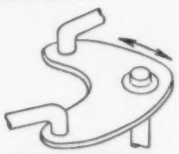


HINGE ACTION
Rivet: Headed on one end, with PUSHNUT on other. Pin: PUSHNUT on each end.



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rector of the British Atomic Energy Research Authority). These are general, non-technical discussions of the atomic power program and how it developed up to the closing months of last year. While they contain no "hot news," they are of great historical interest. (For an up-to-date discussion of the status of atomic energy, see *PE*—April 14, '58, p. 56). Single copies of this 165-pp paperbound book are "furnished without charge to groups for educational purposes."

Rigid Frame Formulas

A. Kleinlogel. *Published by Frederick Ungar Publishing Co., 105 E. 24th St., New York 10. 6 x 9, 460 pp. $14.50.*

Embraces almost all single-span types of rigid frames. Because of the pictorial presentation, formulas for bending moments and reactions may be used without advanced training in structural analysis. Also, the book gives a rapid method for computing displacements of structures, and the rigid frames can be used as units in dealing with cases of more highly indeterminate structures.

The present 12th edition encompasses the same number of pages and frame shapes as the 11th edition. However, 11 frames have been omitted in order to create space for 11 entirely new frame shapes. The former can be obtained as special cases of the tabulated frames.

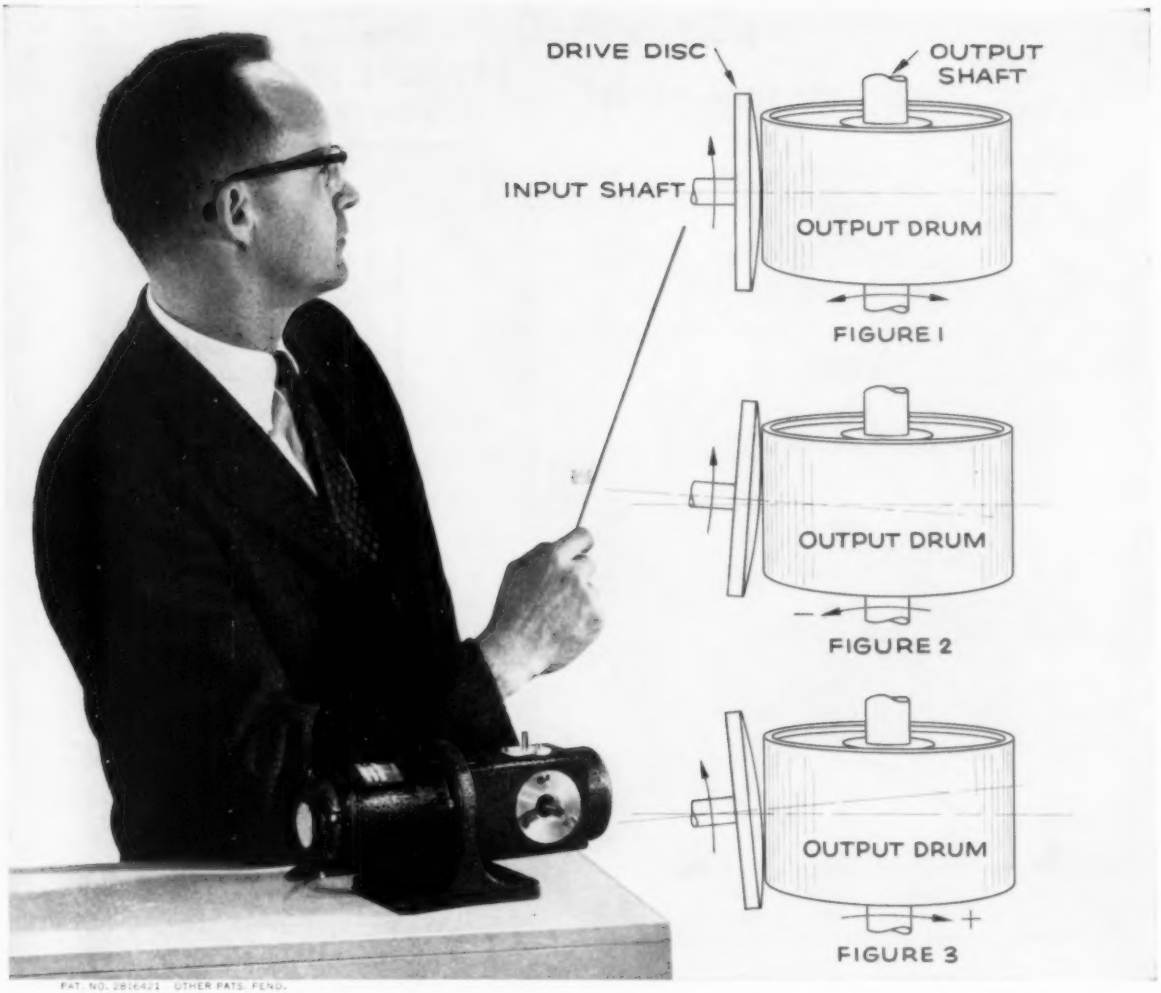
Introduction to Heat Transfer—Third Edition

Aubrey I. Brown and Salvatore M. Marco. *Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36. 6¾ x 9¼, 332 pp. $6.75.*

This is the third edition of a book which, because of its clear and fundamental treatment of the subject, is popular as a college text for third and fourth-year engineering students. Authors intersperse fully worked-out examples with principles and, in addition, show how the principles can be applied to the over-all design of several specific pieces of equipment.

The new edition has been brought

(Continued on page 127)



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In Figure II, the speed control has been shifted so the outer edge of the drive disc touches the outer edge of the output drum for maximum speed in one direction. Figure III shows the position for maximum speed in the other direction. Speed is infinitely variable over the full range.

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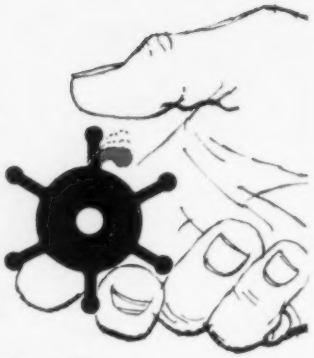

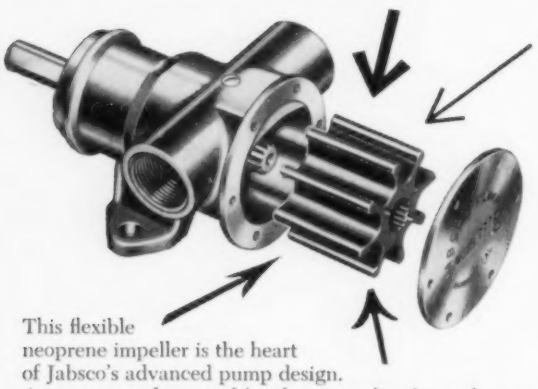

This flexible neoprene impeller is the heart of Jabsco's advanced pump design. As vanes are depressed by the cam, chamber volume is reduced. When vanes are released, they snap back into shape, creating an instant suction. Because of this, Jabsco pumps are *self-priming*, always ready to go! Simple design means low initial cost; easy, inexpensive servicing without removing from the installation!

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Differential	factory set anywhere within limits of 1.5 to 5.0 psia
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Weight	approx. 5 ounces
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Applications	pressuring pumps on air-borne, mobile, or other equipment also in pressurized coaxial cables, in ground radar, and in maintaining frequency bands

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United Electric Controls COMPANY
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up-to-date with the addition of two new chapters: "Fluid Flow in the Convection Process," and "Graphical and Numerical Methods for Heat Conduction Problems." Symbols and notations have been revised to agree with American standards and new material has been added to avoid the familiar difficulties because of a confusion in fundamental units. Further, a new section shows how principles of heat transfer are applied to design of liquid and air-cooled power transformers.

Mechanical Engineering Laboratory

C. W. Messersmith, C. F. Warner, and R. A. Olsen. *Published by John Wiley & Sons, Inc., NYC.* 11½x8½, 179 *pp.* $5.50.

This book is to acquaint undergraduate engineers with the instruments and tools of mechanical engineering. The material is presented so as to require student to refer to textbooks of associated courses. Topics include pressure, temperature and flow measurement, fluid pumps, prime movers, heat transfer and refrigeration.

Aids to Efficient Machine Design in Welded Steel

Published by Lincoln Electric Co., Cleveland 17, Ohio, 8½x11, 48 *pp.* $1.

Valuable for its monographs on how to stiffen flat panels and how to predict torsional resistance and angular twist, booklet also disputes cast iron's claim to fame, its vibration-damping properties and structural stiffness.

(Continued on page 129)

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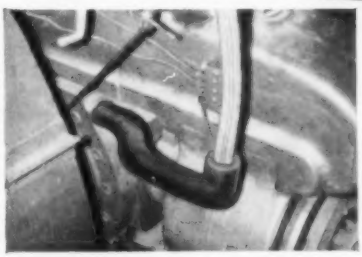

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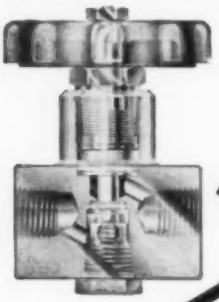

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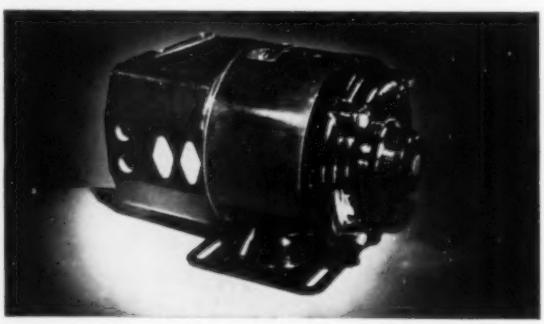

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Since the booklet is obviously prejudiced, it must be used with discretion. It compares welded steel structures with Class 20 gray-cast iron which, of course, exaggerates the advantages for weldments. (Also see *PE*—Mar '57, p 135.) Higher grades of cast irons would make for fairest comparisons.

Effectively edited, this manual lives up to its name. Its aids to efficient design of welded steel can also be applied to castings to achieve better stiffness and lighter weight.

Gas Dynamics

ALI BULENT CAMBEL AND BURGESS H. JENNINGS. *Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36.* 6 x 9, 415 pp. $11.

This book presents the theory and concepts underlying compressible fluid flow, wave phenomena and combustion. The subject matter is applicable and useful in many fields where gases are in motion, either with or without combustion; it is particularly pertinent to the internal-flow problems of jet engines, rocket motors and gas turbines.

The book includes discussions of combustion aerodynamics and introduces over-all aspects of propulsion fundamentals, not in terms of components, but of the broad system. Mathematical analysis is always related to the physical phenomena. Recent advances such as high-velocity combustion phenomena ("aerothermochemistry") and the latest instrumentation techniques are also covered.

Lap Flange Specifications in Easy Steps

Available from Manufacturing Chemists' Assn., Inc., 1625 Eye St., N.W., Washington 6, D. C. 8½ x 10½, 33 pp. $1.25.

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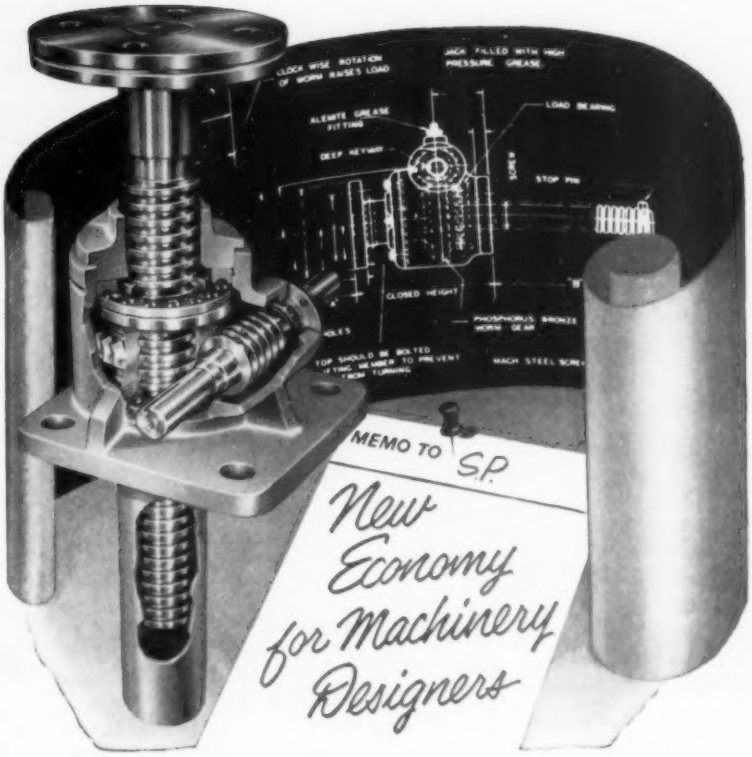
(Continued on page 131)



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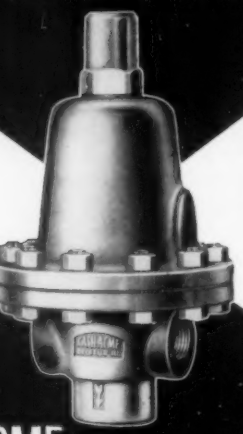

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material to be used in the vessel, gasket, bolts and flange, and a copy of this manual—and away you go.

The pages are taken up with graphs, definitions of terms and a step-by-step guide for using the graphs. This is the work of chemical-industry design engineers who, tired of doing this job the hard way, spent some three years evolving a graphical method of following the ASME code.

High Temperature Wear Evaluation Techniques and Data

ROBERT J. BENZING. *Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C.* 10¾ x 8, 19 *pp.* 75 cents.

A general description is given of modifications required to increase operating temperature potential of following four lubricant testers: Shell four-ball wear tester used for evaluating lubricity of fluids; Shell roll tester used to examine effects of mechanical shearing on grease consistency; bearing endurance grease tester for evaluation of high-speed and high-temperature performance of greases; and hydraulic fluid pump stand for determination of dynamic effects of circulation on shear stability of fluids. The British IAE gear machine, recently acquired for evaluation of the anti-scuffing properties of lubricants, is described.

Lubricity data obtained with the four-ball tester are reported for Specification MIL-O-56-6 hydraulic fluid and MIL-L-7808 turbine engine oil. Wear scar data for various experimental fluids are compared with wear patterns for two specification materials.

"Mason, I suspect you're guilty of overdesigning!"

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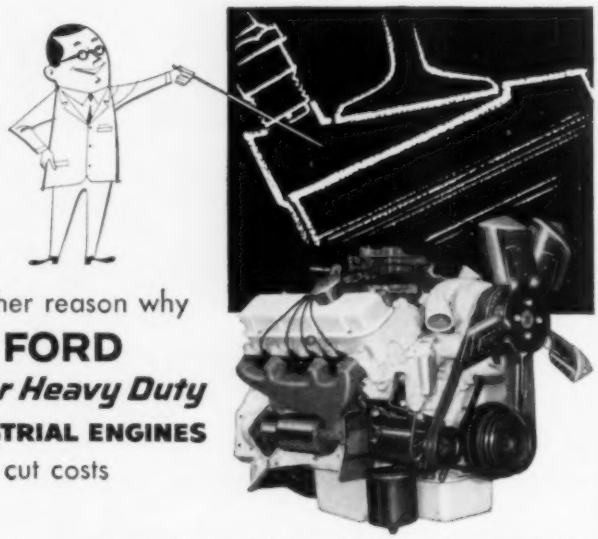

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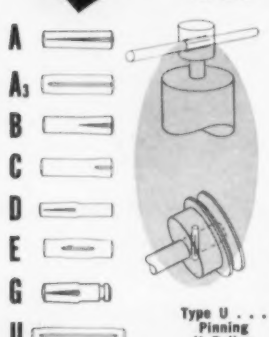

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Mechanical drum recorder offers the simplest way to get T-D records. Comparison between drum camera and its three rivals. July 21, '58, p. 78.
Circle No. E 34

Heavy Metal
How high-density alloys may be used to solve design problems involving space and balancing. July 21, '58, p. 62.
Circle No. E 33

Stresses in Adhesive Joints
How to calculate stress concentrations of 6 basic joints. July 7, '58, p. 64.
Circle No. E 32

Designing with Cantilever Springs
Equations for 7 types show how to triple energy capacity. July 7, '58, p. 58.
Circle No. E 31

Design for Automatic Production
Product, and machine to make it are designed together for small or large quantities. June 23, '58, p. 81. Circle No. E 30

Electrical Control Enclosures
Guide for mounting and protecting controls to meet current standards. June 23, '58, p. 78. Circle No. E 29

Shaftless AC Motors
New look at shell-type power packages. June 9, '58, p. 56. Circle No. E 28

Lubricating Instrument Ball Bearings
Guide to 42 modern oils and greases. Properties and performance charts. June 9, '58, p. 66. Circle No. E 27

Sandwich-panel Adhesives
The 14 most widely specified adhesives, with comparison table. May 26, '58, p. 56.
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(Continued on page 125)

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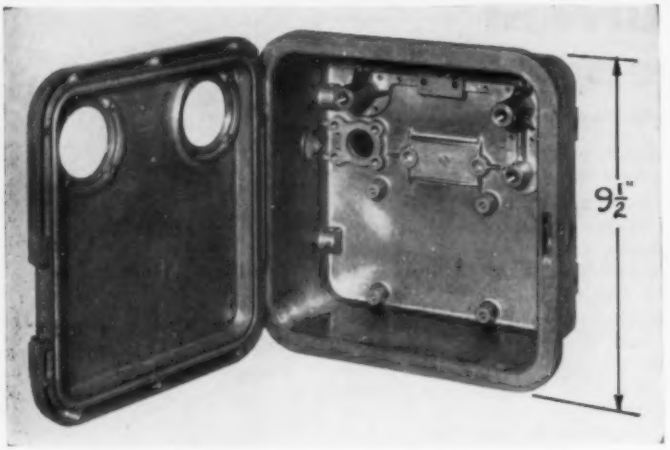

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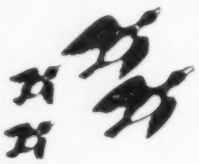

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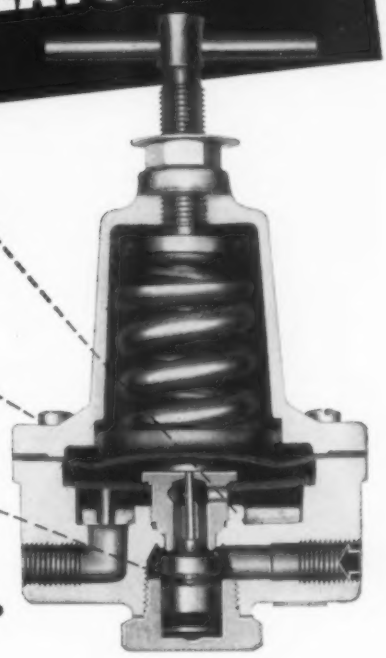
A 16-page printed index of editorial content in all issues for the first six months of 1958 is now ready. Copies may be obtained by circling No. E 35 on one of the Reader Service Cards bound inside the back cover of this issue.

Hereafter, the Index will be issued twice each year, in July and January, and copies will be supplied on request without charge as long as the supply lasts. A limited supply of the Index for Volume 28 is also still available on request.

NEW... Norgren
WATER PRESSURE REGULATORS



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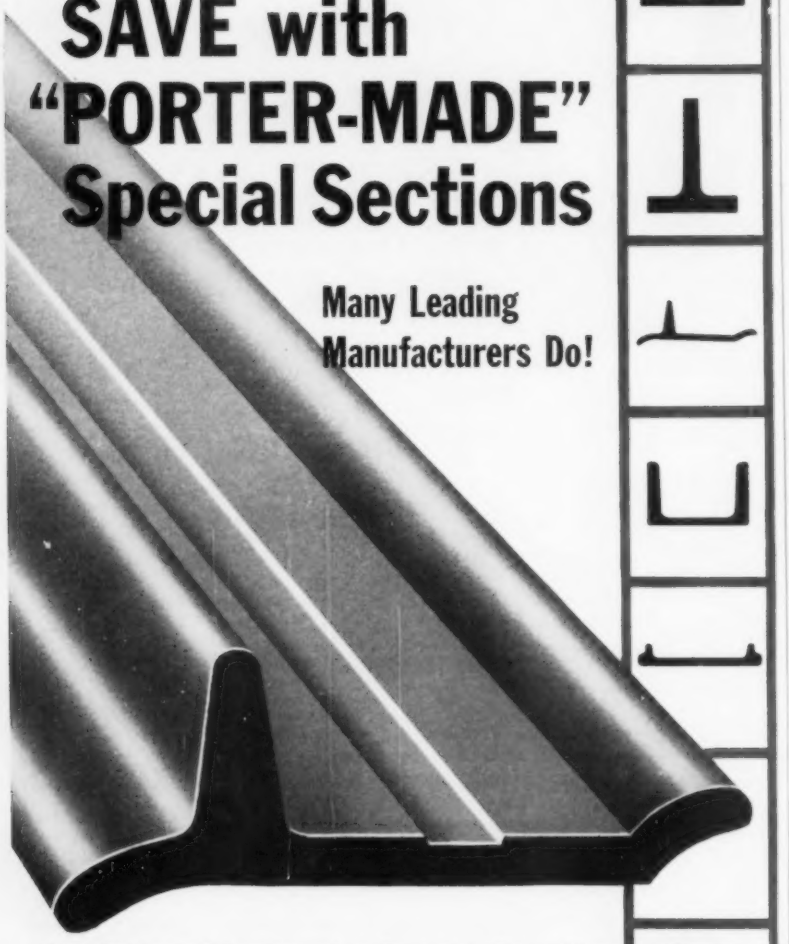

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produced to your precise analyses and specifications.

Engineered to meet your requirements, Special Sections are available in hot rolled, carbon or many alloy grades of steel; from one and a half to forty pounds per foot.

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"Service and Quality"

H. K. PORTER COMPANY, INC.
CONNORS STEEL DIVISION

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"MADE BY ENGINEERS FOR ENGINEERS"

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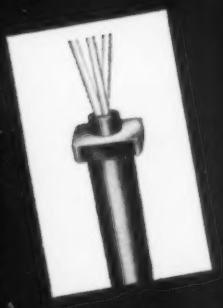

All Cord Sets available in

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to match your appliances, both in Rubber and in Plastic

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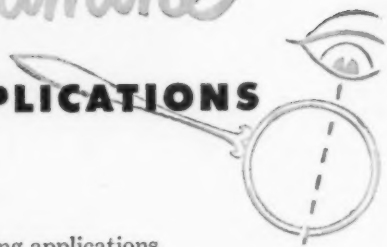

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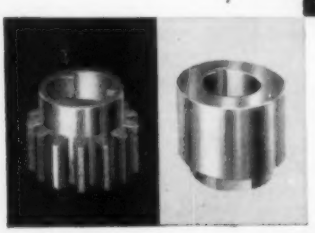

Bunting®

BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities

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Cleveland 13 . . . A. F. Tischer, 1164 Illuminating Bldg., 55 Public Square, Superior 1-7000

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New York 36 . . . B. K. Adams, J. C. Taney, R. G. Wallace, 500 Fifth Ave., Oxford 5-5959

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St. Louis 8 . . . R. W. Bruley, 3615 Olive St., Continental Bldg., Jefferson 5-4867

San Francisco 4 . . . W. C. Woolston, 68 Post St., Douglas 2-4600

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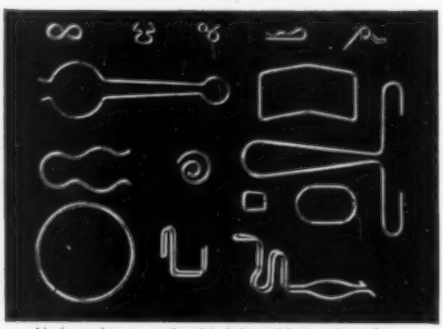

Various shapes made with J & L slide forming wire.

Many types of products are fabricated from stainless steel wire. We suggest you consider Jones & Laughlin Stainless Steel Wire where ease of forming or special corrosion or heat resisting properties are required.

For *your* particular application or production problem, we offer the services of our stainless steel specialists. A letter or call will receive prompt attention.

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Improve your Products with . . .
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Issue of July 21, 1958
Product Engineering
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NEW YORK, N. Y.

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

5¢ Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING—
330 WEST 42nd STREET
NEW YORK 36, N. Y.

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Use these convenient cards for a

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E24. Semiconductor Rectifiers
Comparison of germanium and silicone rectifiers. (5/12/58)

E25. Coriolis Acceleration
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E26. Sandwich-panel Adhesives
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E27. Lubricating Ball Bearings
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E28. Shaftless Ac Motors
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E29. Electrical Control Enclosures
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E31. Designing with Cantilever Springs
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E34. Time-displacement Records
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32—Drafting Pencil

33—Drafting-reference Unit

METALS AND ALLOYS

8—High-temperature Alloy

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Key No. Specific Product

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Please print or type

NAME ..... POSITION .....

COMPANY .....

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* WHERE ADVERTISEMENTS LIST MORE THAN ONE PRODUCT, INDICATE IN BOX ON CARD THE ITEM NUMBER *AND* SPECIFIC PRODUCT IN WHICH YOU ARE INTERESTED.

New Catalogs and

GENERAL ENGINEERING

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53—Microfilm System for Drawings, 16 pp., Filmsort Co.

NON-METALLIC MATERIALS, FINISHES

55—Asbestos-Fiber Filler, 4 pp., Johns-Manville.

FABRICATION PROCESSES AND PRODUCTION

44—Screw Machine Blanks, 2 pp., National Screw Machine Products Assoc.

56—Titanium Machining, 8 pp., Mallory-Sharon Metals Corp.

57—Specialized Heat Treatments, 8 pp., Ferrotherm Co.

POWER TRANSMISSION

42—Torque Actuators, 20 pp., Ex-Cell-O Corp.

MECHANICAL PARTS

40—Aluminum Flattened Wire, 6 pp., Kaiser Aluminum & Chemical Sales.

45—Teflon-coated Wire, 4 pp., Chemplast, Inc.

48—Industrial Wheels, 6 pp., Faultless Caster Corp.

51—Precision Gears, 4 pp., Western Gear Corp.

58—Cable Assembly, 24 pp., Bergen Wire Rope Co.

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Components and Materials Appearing on Pages 89-110

POWER TRANSMISSION

26—Helical-gear Speed Reducer
27—Plastic Speed Reducer
30—Tachometer Generator

FASTENING AND JOINING

22—Torque-sensitive Coupling

ELECTRICAL ELECTRONIC COMPONENTS

12—Low-temp Primary Battery
13—Emergency Three-circuit Switches
17—Subminiature Switch
20—Mercury Switch for 100-amp
24—Multiple Circuit Slide Switch
28—Circuit-breaking Receptacles
31—Insulated Magnet Wire

MOTORS, ENGINES AND CONTROLS

1—Encapsulated Motor Stator
2—Adjustable Pressure Transducer
5—Analog-to-Digital Converter
6—Electrically Controls Pressure

MECHANICAL PARTS

16—Flange Ball-bearing Mount
18—45 Micron High-temp Filter
25—Sintered Metal Bearings
29—Magnetic Filters

HYDRAULIC, PNEUMATIC EQUIPMENT

2—Locking Toggle in Cylinder
7—Variable Displacement Pumps
9—Directional Control Valve
10—Coiled Nylon Air Hose
11—Remote Control Midget Valve
14—Check Valve
15—Hydraulic Steering Valve
23—Check Valve for 0 to 3000-psi

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* Multiple product ads.

Key No.	Specific Product

Bulletins (p. 112-116)

FASTENING AND JOINING

36—Quick-connect Couplings, 26 pp., Snap-Tite, Inc.
45—Flexible Couplings, 8 pp., T. B. Wood's Sons Co.

MOTORS, ENGINES AND CONTROLS

34—Remote, Mechanical Controls, 36 pp., Arens Controls, Inc.
37—Liquid-level Control, 16 pp., B/W Controller Corp.
41—Index Tables, 12 pp., Ferguson Machine Corp. of Indiana.
47—Rotating and Control Equipment, 6 pp., Electrical Drive, Safety Industries.
49—Variable-speed Control, 8 pp., U. S. Electrical Motors, Inc.

ELECTRICAL, ELECTRONIC COMPONENTS

35—Electronic, Electrical Components, 76 pp., Cambridge Thermionic Corp.
39—Glass Mercury Switches, 8 pp., Gordos Corp.
46—Electrical and Lubricating Devices, 8 pp., Trico Fuse Mfg. Co.
52—Miniature Lampholders, 1 pp., Drake Mfg. Co.
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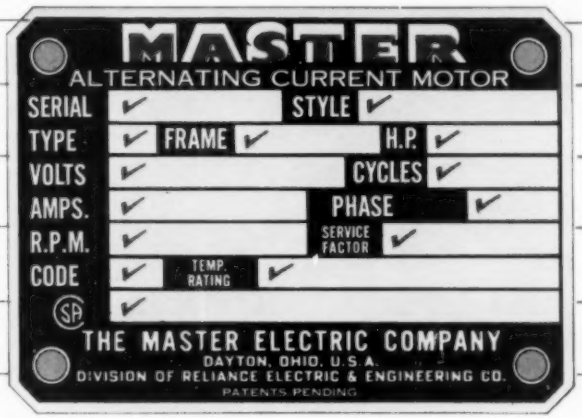

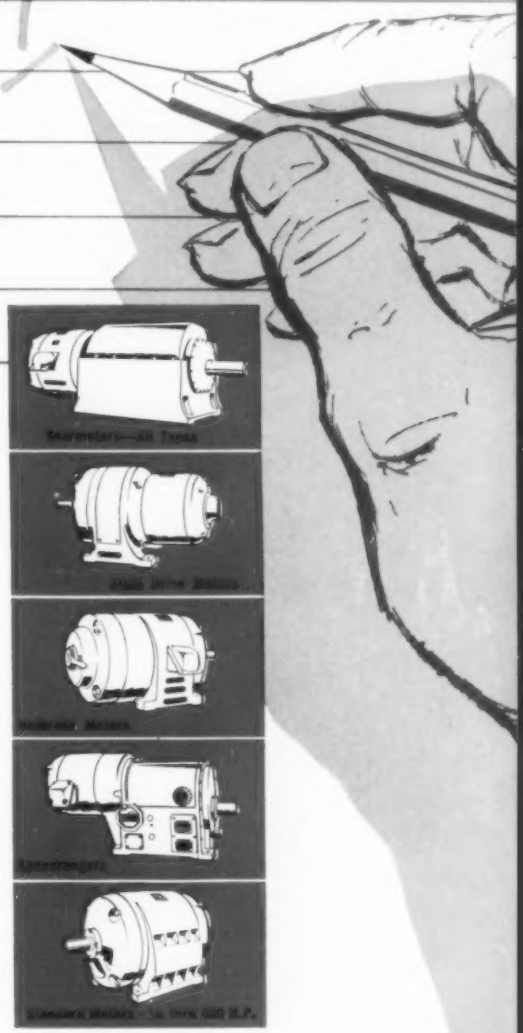

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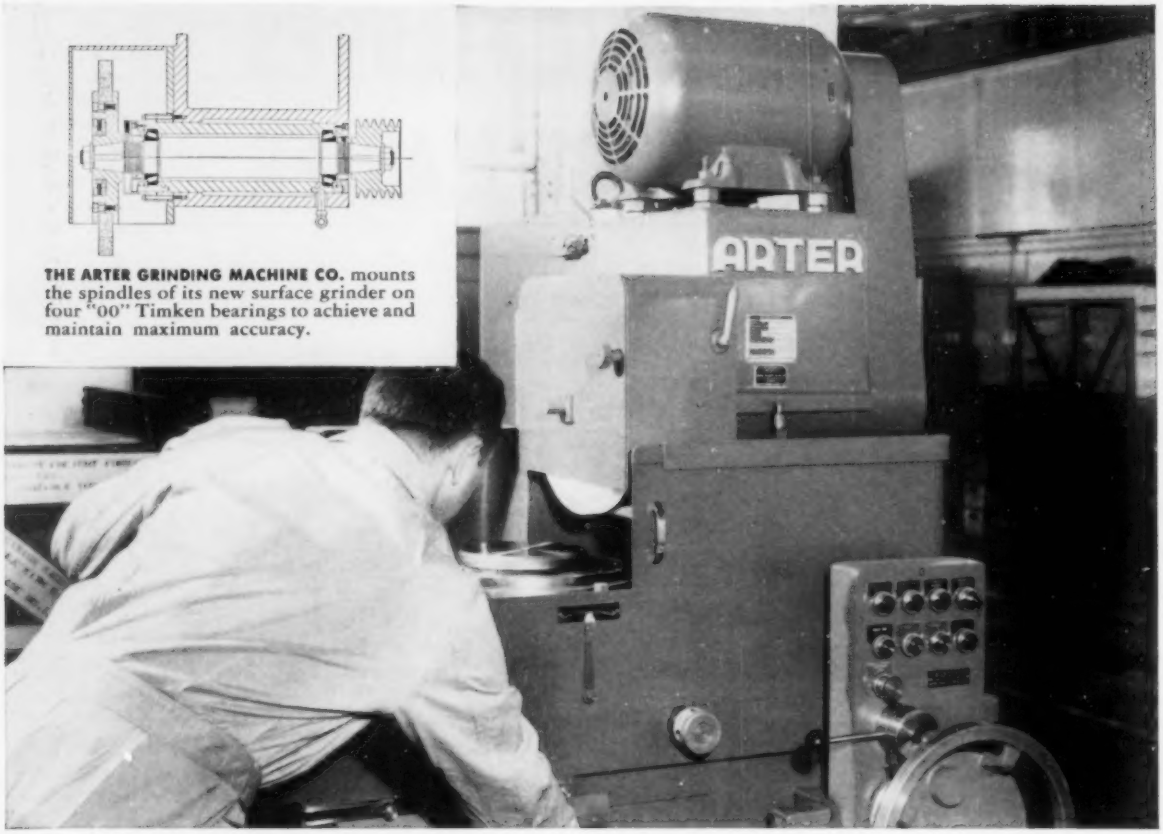

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